Answers

Section 1 The nature and variety of living organisms

B1a Characteristics of living organisms

Page 11

1. a) Any suitable answers for human, such as:

   movement: walking; respiration: combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity: vision; homeostasis: control of core body temperature; growth: increase in height; reproduction: having a baby; excretion: producing urine; nutrition: eating food

   b) Any suitable answers for a specific animal, such as:

   movement: crawling; respiration: combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity: smell; homeostasis: control of body water content; growth: increase in length; reproduction: producing young; excretion: losing carbon dioxide through respiratory surface; nutrition: eating food

   c) Any suitable answers for a plant, such as:

   movement: growing towards light; respiration: combination of oxygen with glucose to release energy, carbon dioxide and water; sensitivity: detecting direction of light; homeostasis: controlling loss of water through stomata by opening and closing them; growth: increase in height; reproduction: producing seeds; excretion: diffusion of waste products out of leaf for photosynthesis (oxygen) and respiration (carbon dioxide); nutrition: taking in nutrients from soil and making glucose by photosynthesis

2. Movement – to reach best place to get food or other conditions favourable for growth

   Respiration – to release energy from food that can be used for all life processes

   Sensitivity – to detect changes in the environment

   Homeostasis – to prevent damage being done to cells as a result of changes in the body

   Growth – to increase in size until large/mature enough for reproduction

   Reproduction – to pass genes on to next generation

   Excretion – to remove harmful substances from body

   Nutrition – to take in substances needed by the body for growth and reproduction

Page 12

1. Reproduction

2. Movement – viruses cannot move themselves. Respiration – viruses do not respire. Sensitivity – viruses do not sense or respond to changes in the environment. Growth – viruses do not build new materials within their structure to produce a permanent increase in size. Excretion – viruses do not carry out metabolism, so they do not have waste products to excrete. Nutrition – viruses do not take in food substances for use in respiration or to build new materials.

3. Any suitable argument with justification, such as non-living materials do not reproduce, so viruses must be living.

4. Any suitable argument with justification, such as viruses cannot live independently of other organisms and show just one of the eight characteristics of living organisms, so they cannot be classed as living.

Worksheet B1a.1a

The leaves of some plants track the Sun's movement across the sky during the day. **movement/sensitivity**	At night a plant gives out carbon dioxide. **respiration**	Humans produce urine every day, which contains waste products from the body, as well as any water that the body doesn't need. **excretion**
The air that you breathe out of your lungs contains more carbon dioxide than the air that you breathed in. **respiration**	Humans give birth to live babies, but birds and reptiles lay eggs from which the young hatch. **reproduction**	During the first year of life a human baby may triple its birth weight. **growth**
A *Mimosa* plant responds to touch by wilting. **sensitivity**	A student runs a 400 m race. **movement**	The green colouring of plant leaves is chlorophyll, which plants use to make food. **nutrition**
A healthy diet includes a good balance of protein, fruit and vegetables. **nutrition**	Flowering plants produce seeds that can be grown to produce new plants. **reproduction**	If you receive a shock, your heart usually starts to beat more quickly. **sensitivity**
Trees add another ring of wood around their trunks each year. **growth**	A house plant in the kitchen grows towards the window. **sensitivity/growth**	A bacterium in ideal conditions can divide into two every 20 minutes. **reproduction**

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	Movement, respiration, sensitivity, homeostasis, growth, reproduction, excretion, nutrition Any suitable sentence.	8 marks 1 mark
2	Nutrition and respiration	2 marks
3	Dry mass is the mass of all the materials used to make the cells and tissues of the body. Water content in the body varies as water is gained and lost so wet mass is not reliable.	1 mark 1 mark
4	The crystal gains in size as more of the substance in solution attaches to the crystal, but this is not true growth. because the substance can be lost to solution too, so this is not a permanent increase.	1 mark 1 mark
5	Animals are not 'more alive' just because they have to move around to get their food, etc. Plants must remain attached to the ground because that is where they get support, water and nutrients. Both plants and animals show all the life processes, so are equally 'alive'.	1 mark 1 mark
6	The tree does not move during winter, although the cells may still move. Respiration and therefore excretion may still occur, but at a very slow	1 mark 1 mark

	rate (as gas exchange continues slowly through the bark). Movement, reproduction, growth and sensitivity will not take place during winter. However, as long as the tree has the capacity to return to a state where it can carry out all these processes (when leaves grow, during the rest of the year), it is still alive.	 1 mark 1 mark
	Total:	21 marks

B1b.1 Classifying organisms

Page 16 (top)

1. Multicellular means made of many cells, such as human, plant, etc.

2. The xylem vessels in the stems and leaves are strong, so help to support the plant. Water in the cells, when the cells are turgid, also support the plant as it pushes against the cell walls.

3. Chloroplast

Page 16 (bottom)

1. a) Nucleus, cytoplasm, cell membrane

   b) Cell wall, large central vacuole, possibly chloroplasts

2. Animals have nervous systems and organs for movement that plants do not have

3. Animals need to move around to find food, or to find suitable habitats to live in. Plants need to take water and nutrients from the ground, so they need roots in the ground.

Page 18

1. a) Cell walls and central vacuole, cannot move around.

   b) No chloroplasts, may store carbohydrate as glycogen.

2. Saprotrophic nutrition is the digestion of dead material by external digestion, where enzymes are secreted onto the food and the digested food is then absorbed into the body. Animals eat the food (sometimes from living/just killed organisms) and digest the food inside their alimentary canal.

3. Toadstools and mushrooms are the reproductive structures of fungi. The main body of the fungus is the mycelium, the mass of tiny thread-like hyphae, which is often below the surface of the ground.

Page 20

1. Any three from:

- plant cells have cellulose cell walls, bacterial cells may have a cell wall made of other chemicals
- plant cells have a nucleus containing chromosomes, bacterial chromosome lies free in cytoplasm
- bacterial cell may contain one or more plasmids, plant cell has no plasmids
- plant cells have large vacuole/chloroplasts, bacterial cells do not.

2. Some contain a chloroplast and can photosynthesise as some plant cells do, others do not have chloroplasts and feed on other organisms, so are more like single animal cells.

3. Bacteria are single cells, no nucleus, cell wall, single chromosome lying free in cytoplasm; protoctists have a nucleus containing the chromosomes, may contain chloroplasts and are much larger than bacterial cells.

Page 22

1. Outer protein coat surrounding genetic material

2. They do not have most of the characteristics of a living cell, and behave like particles until they have infected a cell.

3. Viruses are much smaller than bacteria, in the region of 100 nm (100×10^{-9} m) compared with 2 μm (2×10^{-6} m).

Worksheet B1b.1a

	Food source	Cell wall?	Nucleus in cell?	Carbohydrate store	Single or multicelled?
Plants	make own food using light energy from Sun	yes, cellulose	yes	starch or sucrose	multicelled
Animals	eat other organisms	no	yes	glycogen	multicelled
Fungi	extracellular digestion of dead or living plant or animal tissue	yes, chitin	yes	sometimes glycogen	some single-celled, some multicelled
Bacteria	some have photosynthesis, some feed off dead or living tissue	yes, variable	no – chromosome lies free in cytoplasm	no	single-celled
Protoctists	some have photosynthesis, some feed on living organisms or dead matter	some	yes	–	single
Viruses	none	no	no	no	not really a cell

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	viruses, bacteria, protoctists	2 marks
2	<table><tr><th></th><th>Multicellular or single-celled</th><th>Key cell structures</th><th>Food store</th><th>Other distinguishing features</th></tr><tr><td>plants</td><td>multi</td><td>cell wall, large central vacuole, may have chloroplasts, cell membrane, nucleus, cytoplasm</td><td>starch or sucrose</td><td>may be woody and very tall, such as a tree photosynthesis</td></tr><tr><td>animals</td><td>multi</td><td>cell membrane, nucleus, cytoplasm</td><td>glycogen (and fat)</td><td>move around</td></tr><tr><td>fungi</td><td>multi</td><td>cell membrane, nucleus, cytoplasm, cell wall</td><td>glycogen</td><td>saprotrophic nutrition, mushrooms/ toadstools are reproductive structures main body is mycelium, made of hyphae</td></tr></table>	20 marks

	bacteria	single	cell membrane, cytoplasm, free chromosome, cell wall, may have plasmids	–	wide range of form and size	
	protoctists	single	cell membrane, nucleus, cytoplasm, may have chloroplast	–	some more like animal cells, other more like plant cells	
	viruses	–	–	–	protein coat containing genetic material that infects other cells so that it can reproduce	
3	They both contain cells with typical plant cell features such as cell wall, large central vacuole and may have chloroplasts.					1 mark 1 mark
4	It is an animal. because animal cells have no cell wall and do not photosynthesise.					1 mark 1 mark
5	a) A pathogen is an organism that causes disease in another organism. b) and c) Example and corresponding disease, any appropriate, such as: fungi – ringworm in humans causes skin lesions, moulds or rusts in plants bacteria – *Pneumococcus* causes pneumonia protoctists – *Plasmodium* causes malaria viruses – influenza virus in humans and other animals or HIV in humans, tobacco mosaic virus in plants					1 mark 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
6	They can only reproduce when inside the cell of another organism and cannot live independently.					1 mark 1 mark
7 a)	They have characteristics in common with each of the other groups, so depending on which characteristics are used for grouping, they could be grouped as either animals or plants.					1 mark 1 mark
7 b)	They are too different from plants and animals to be comfortably grouped together. Also, further information about their structure indicates that they are too different from plants and animals to be grouped with them.					1 mark 1 mark
	Total:					39 marks

Section 1: Exam-style questions mark scheme

Question	Correct answer	Marks
2 a)	i) A: *Amoeba*	1 mark
	B: *Chlorella*	1 mark
	ii) D: *Pneumococcus*	1 mark
	iii) B: *Chlorella*	1 mark
	iv) C: *Lactobacillus*	1 mark
	D: *Pneumococcus*	1 mark

	v) C: *Lactobacillus*	1 mark
	vi) D: *Pneumococcus*	1 mark
2 b)	i) A: nucleus	1 mark
	B: cell membrane	1 mark
	C: cytoplasm	1 mark
	ii) organelles	1 mark
3	Viruses are not cellular/they consist of nucleic (RNA or DNA) acid surrounded by a protein coat.	1 mark
	They cannot live (or at least not for very long) outside the cells/body of an organism/ they are parasitic.	1 mark
	They do not have the eight characteristics of living things (MRS H GREN).	1 mark
	Plus one extra mark for mentioning any of the following:	
	Some viruses **move** but many rely on other organisms to get them inside host cells or transport mechanisms in their host to transport them around	1 mark
	Viruses **reproduce** but they are dependent on being inside a host to do this and it is unlike reproduction in other organisms (it involves a copying of their DNA or RNA and assembling a protein coat around them)	1 mark
	They are **sensitive** to their environment in that they can gain entry into their host cells	1 mark
	They do not **grow** in the normal sense (they are assembled); they do not **respire** or **excrete** and do not require **nutrition**/ feed	1 mark
	So most scientists do not regard them as living organisms.	1 mark
4 a)	Maize (or any other example) – cereal crop	1 mark
	Peas/beans (or any other example) – legume	1 mark
4 b)	Human (or any other example) – mammal	1 mark
	Housefly/mosquito (or any other example) – insect	1 mark
4 c)	i) Nervous system/ hormonal or endocrine system	1 mark
	ii) Tropism (or named tropism – phototropism or geotropism)	1 mark

Section 2 Structures and functions in living organisms

B2a Levels of organisation

Page 31

1. Any two from: nucleus, vacuole, chloroplast

2. a) Any two suitable such as: muscle, nervous, epithelium (lining), blood, bone

   b) Each from a) with suitable adaptations, such as:

   - muscle tissue can contract to move bones or other parts of body
   - nervous tissue can carry electrical impulses
   - epithelium tissue has smooth surface and may have adaptations such as cilia to move substances across surface
   - blood contains cells that carry oxygen, plasma that carries dissolved food substances, etc.
   - bone tissue is hardened to make strong bones.

3. a) Any two suitable such as: xylem, phloem, epidermal, mesophyll

   b) Each from a) with suitable adaptations, such as:

   - xylem: long tubes through which water moves from roots through stems to other parts of the plant
   - phloem: living cells that transport food, etc. around plant
   - epidermal tissues: in continuous layers across surfaces of plants to prevent pathogens entering
   - mesophyll: packs other tissues to hold them all in place

Page 33

1. Any two suitable such as:

- heart: pumps blood round body
- kidneys: remove waste substances from body
- liver: controls many processes in body
- brain: coordinates thought, response to stimuli

2. Any two suitable such as:

- leaf contains cells with chloroplasts for photosynthesis
- roots have root hair cells where water and dissolved nutrients are absorbed into the plant
- stem contains strengthening tissue in xylem, etc. to support other parts of plant

3. A body system is a group of organs that work together to carry out the life processes in an organism.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	System, organ, tissue, cell	3 marks
2 a)	A group of similar cells that carry out a similar function	1 mark
2 b)	Several tissues that are grouped together to carry out a particular function	1 mark
2 c)	Several organs that work together to carry out a particular function	1 mark
3	Any suitable answers, such as:	

<table>
<tr><td></td><td>a) palisade cell/root hair cell; xylem tissue/mesophyll tissue; leaf/root
b) muscle cell/nerve cell; muscle tissue/secretory tissue; heart/lungs</td><td>3 marks
3 marks</td></tr>
<tr><td>4</td><td>Any three suitable systems, such as:
<table>
<tr><th>System</th><th>Function</th><th>Organs in this system</th><th>Tissues in these organs</th><th>Cells in these tissues</th></tr>
<tr><td>respiratory</td><td>gas exchange between body and atmosphere</td><td>lungs</td><td>epithelial tissue lining tubes and air spaces</td><td>epithelial cells</td></tr>
<tr><td>nervous</td><td>receives stimuli from surroundings and coordinates responses</td><td>brain
spinal cord
nerves</td><td>nervous tissue</td><td>nerve cells</td></tr>
<tr><td>circulatory</td><td>to carry substances around the body</td><td>heart
blood vessels</td><td>muscle tissue
epithelial tissue
blood</td><td>muscle cells
epithelial cells
blood cells</td></tr>
</table></td><td>15 marks</td></tr>
<tr><td>5</td><td>epidermis – to cover and protect the outer surfaces of the leaf
palisade tissue – contains cells that photosynthesise
xylem tissue – long tubes that carry water
mesophyll tissue – packing cells that support other tissues</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>6</td><td>By differentiating cells, the body of a multicellular organism can develop in many different ways, such as developing muscles for rapid movement or producing flowers for reproduction.
This makes a huge range of different body designs possible,
and means that the cells, tissues, organs and systems can carry out the life processes more efficiently.</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td></td><td>Total:</td><td>34 marks</td></tr>
</table>

B2b Cell structure

Page 37 (top)

1. a) Drawing should be drawn with thin, clear pencil lines, no crossing out, to show the outline of the cell in the photograph and the central shape.

   b) Diagram should be labelled to show nucleus, cytoplasm and cell membrane.

Page 37 (bottom)

1. a) Chloroplast

   b) Large vacuole

   c) Cell wall

Developing investigative skills, page 38

1. a) Place the slide on the microscope stage under a low power objective. Use the stage clips to hold the slide in place. Make sure the light source passes through the slide to the objective (but not focused sunlight). Use the coarse focussing knob to bring the slide into focus as far as possible. Then use the fine focussing knob to get the best focus.

   b) The specimen should always be focussed at low power before moving the high power objective into position. Then only the fine focussing knob should be used to focus at high power. This should avoid crashing the objective into the microscope slide, because the high power objective is longer than the low power objective.

   c) Make sure that the sunlight is not shining directly on the mirror, so that the light might be focussed through the microscope into the eye, as this can damage the eye.

2. a) A careful drawing with clean sharp pencil lines, of the white blood cell, labelled to show the nucleus, cell membrane (not really visible at this magnification but understood to be at the edge of the cell) and cytoplasm.

   b) Magnification = eyepiece ($\times$4) $\times$ objective ($\times$20) = $\times$80.

   c) The cells are animal cells. They don't have features of plant cells, e.g. cell wall, large vacuole.

End of Topic Questions mark scheme

<table>
<tr><th>Question</th><th>Correct answer</th><th>Marks</th></tr>
<tr><td>1 a)</td><td>The structure that contains the genetic material and controls cell division</td><td>1 mark</td></tr>
<tr><td>1 b)</td><td>The structure surrounding a cell that controls what enters and leaves the cell</td><td>1 mark</td></tr>
<tr><td>1 c)</td><td>The material inside the cell that contains the organelles and in which many reactions take place</td><td>1 mark</td></tr>
<tr><td>2</td><td>Table similar to the following, showing the same information:
<table>
<tr><th>Plant cell</th><th>Animal cell</th></tr>
<tr><td>has a nucleus</td><td>has a nucleus</td></tr>
<tr><td>surrounded by cell membrane</td><td>surrounded by cell membrane</td></tr>
<tr><td>surrounded by cellulose cell wall</td><td>no cell wall</td></tr>
<tr><td>cytoplasm fills cell</td><td>cytoplasm fills cell</td></tr>
<tr><td>usually large central vacuole</td><td>no large central vacuole</td></tr>
<tr><td>may contain chloroplasts</td><td>no chloroplasts</td></tr>
</table></td><td>12 marks</td></tr>
<tr><td>3 a)</td><td>Animal cells are surrounded by a cell membrane that controls what enters and leaves the cell.</td><td>2 marks</td></tr>
<tr><td>3 b)</td><td>Some plant cells contain chloroplasts.</td><td>2 marks</td></tr>
<tr><td>3 c)</td><td>Only plant cells contain a large central vacuole in the middle of the cell.</td><td>2 marks</td></tr>
<tr><td>4</td><td>As red blood cells have no nucleus, there is nothing to control cell division, so they cannot divide like many other cells to replace damaged cells. So they have to be replaced with cells from the bone marrow.</td><td>2 marks</td></tr>
<tr><td></td><td>Total:</td><td>23 marks</td></tr>
</table>

B2c Biological molecules

Page 43

1. a) Fatty acids and glycerol b) Simple sugars c) Amino acids

2. Protein is formed from amino acids, carbohydrates from simple sugars; carbohydrates often made from one kind of simple sugar, proteins from many different kinds of amino acids.

3. a) i) The blue solution would change colour and an orange-red precipitate would form, because glucose is a reducing sugar.

ii) The solution wouldn't change colour as there is no starch present.

b) i) There would be no change in colour because sucrose and the starch in wheat flour are not glucose (reducing sugars).

ii) The brown solution would turn blue-black because of the starch in flour.

Developing investigative skills, page 47

1. Similar strips of film would be placed in separate tubes, with the protease, and each tube placed immediately in a separate water bath at each of the temperatures shown in the table. The stopwatch would time from the moment each tube is placed in the water bath, and the tubes would be checked frequently to find the time at which the film became completely clear.

2. Graph with temperature along *x* axis and time on *y*-axis. Points clearly marked and joined with straight lines.

3. The rate of reaction increases up to an optimum temperature of about 30 °C, and then decreases again.

4. The enzyme has an optimum temperature, below which and above which the enzyme works more slowly. At higher temperatures, this is because the enzyme is denatured by the heat.

5. Test at more temperatures between 20 and 40 °C.

Page 47

1. A chemical that is found in living organisms that speeds up the rate of reactions

2. Proteins

3. Without enzymes, the metabolic reactions of a cell would happen too slowly for life processes to continue.

4. As temperature increases, the rate of the reaction will increase, up to a maximum point (the optimum) after which it decreases rapidly as the enzyme is denatured.

Activity B2c.3 Consolidation and summary

Learning objectives

- To review the learning points of the topic
- To test understanding through answering questions

Learning outcomes

- Be familiar with the knowledge and understanding summarised in the End of Topic Checklist
- Be able to apply this knowledge and understanding by answering the End of Topic Questions

Resources

Student Book pages 48–50

Approach

Ask students to answer the End of Topic Questions in the Student Book.

Answers

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	They are found in all the basic and most common large molecules of the body, such as carbohydrates, proteins and lipids.	1 mark 1 mark
1 b)	To make proteins and other compounds needed in the body	1 mark
2	Three fatty acids and one glycerol molecule for each lipid that was broken down	1 mark 1 mark
3	Only lactose and fructose would react because they are small sugars. Starch is a large molecule which doesn't react with this reagent.	1 mark 1 mark
4 a)	The tests before the experiment show that the bread contained starch but no glucose (reducing sugar). The tests after the experiment show that the solution contains glucose (reducing sugar) but no starch.	1 mark 1 mark
4 b)	The starch in the bread has been changed into glucose (reducing sugar). Starch is a large carbohydrate, and glucose is the basic unit of carbohydrates, so the starch has been digested. Substance A is an enzyme, such as amylase, that digests carbohydrates.	1 mark 1 mark
5 a)	The leaf would turn dark blue-black.	1 mark
5 b)	The blue-black reaction shows the presence of starch, which has been produced as a result of photosynthesis in the leaf due to presence of light and chloroplasts.	1 mark 1 mark
5 c)	No change of colour from orange-brown.	1 mark
5 d)	No starch has been produced, because there has been no photosynthesis. because there was no light and photosynthesis only occurs in light.	1 mark 1 mark
6 a)	The temperature at which an enzyme-controlled reaction is at its fastest rate.	1 mark
6 b)	Sketch should be like the one on page 44 (left) of the Student Book, labelled to show increasing rate as temperature increases from 0 to optimum because molecules are moving around faster and can interact faster optimum temperature when reaction is proceeding as quickly as it can reducing rate of reaction above optimum where heat is causing the enzyme/active site to change shape so it cannot interact with the	1 mark 1 mark 1 mark 1 mark

	substrate as well, and eventually is denatured.	
6 c)	It is most likely to be around 37 °C because that is the temperature in the core of the human body, including the digestive system where this enzyme is found.	1 mark 1 mark
7 a)	Respiration	1 mark
7 b)	Breathed out through the lungs	1 mark
7 c)	It would increase, because muscle cells need more energy and so respiration would be happening faster.	1 mark
7 d)	It would make the conditions more acidic.	1 mark
7 e)	The pH change could affect the enzymes, reducing the rate of many cell reactions. If reactions that are involved in the key life processes slow down, this could damage the cell/organism.	1 mark 1 mark
	Total	30 marks

B2d Movement of substances into and out of cells

Page 54

1. Any answer that means the same as the following:

   net movement – the sum of movement in all the different directions possible

   diffusion – the sum of the movement of particles from an area of high concentration to an area of lower concentration in a solution or across a partially permeable membrane

2. Passive, because no energy is provided by the cell for it to happen

3. a) Glucose can but starch cannot

   b) Only particles that are small enough to pass through the holes in the membrane can diffuse. Larger molecules cannot diffuse through the membrane.

Page 56

1. The concentration of water molecules will reduce.

2. Decrease

3. It will cause water molecules to move into that cell from surrounding cells by osmosis as a result of the water concentration gradient.

4. It will reduce the concentration of water molecules in the cells.

5. Decrease

6. Water molecules will move into those cells from surrounding cells by osmosis as a result of the water concentration gradient.

7. Water molecules move out of the root hair cells into neighbouring cells due to changing water concentration gradient across the root cells to the xylem. This increases the water concentration gradient between the root hair cells and the surrounding soil water, so more water molecules enter the plant through the root hair cells.

Developing investigative skills, page 58

1. Plan should include:

- cutting stems with sharp knife/scalpel to give accurate size and reduce damage to cells near the cut
- using a ruler or similar to measure the lengths and widths of the pieces when cutting
- placing cut pieces into water for storage until investigation begins, to prevent cells drying out
- accurate preparation of solutions of different concentrations given in diagram
- quickly placing pieces into each solution so they all have the same time in solution
- ideally, use of several pieces of stem in each solution (two are shown in the diagrams, but more might be better) so that results from different pieces can be averaged to give a more accurate result (since living things can vary).

2. The diagrams show that in solutions of concentration less than 0.25M/l, the inner cells enlarge and can cause the strips to curve with the outer surface on the inside. In 0.25M/l there is little change in the strips, and in the most concentrated solution (0.5M/l), the strips curve more with the outer layer still on the outside.

3. Osmosis results when there is a concentration gradient for water across a partially permeable membrane. In the solutions of concentration less than 0.25M/l, the inner cells gain water. As the outer cells don't change as much, because of the waxy layer, the increase in turgidity of the inner cells causes the strips to curve with the inner layer on the outer side of the curve. In the most concentrated solution, the inner cells have lost water as a result of osmosis and got smaller, and so the strips have curved even more than they normally do, with the outer layer on the outside.

4. The normal concentration of cell cytoplasm of dandelion cells appears to be about 0.25M/l because these strips changed least, suggesting there was little osmosis between the cells and solution and so there is no concentration gradient between them.

Page 59

1. Any answer that means the same as the following: the net movement of water molecules from a region of their higher concentration to a region of their lower concentration.

2. a) It is a passive movement of molecules as the result of a concentration gradient.

b) Osmosis only considers movement of water molecules, diffusion considers solute molecules.

3. Diagram should show water molecules leaving the red blood cell as a result of osmosis and entering the solution.

4. The strong cell wall prevents more water entering a plant cell than there is space for in the cell, that is, when the cell is turgid. Turgid cells have a specific shape, as a result of the cell wall, and this supports the plant, keeping it upright.

Page 60

1. Concentration gradient, temperature and surface area

2. Any answer that means the same as the following: if there are more solute particles (that is, in a more concentrated solution) then, over a period of time, more of them will have moved to the area of lower concentration. So rate of diffusion is faster.

3. As size increases, area increases by the square, but volume increases by the cube of the length. This means that volume increases faster than area, so the ratio of surface area to volume must get smaller.

Page 61

1. Active transport is the absorption of a substance by a cell against its concentration gradient, using energy.

2. Uptake of nitrate ions by root cells in plants, uptake of glucose from kidney tubules into the blood in animals.

End of Topic Questions mark scheme

<table>
<tr><th>Question</th><th>Correct answer</th><th>Marks</th></tr>
<tr><td>1</td><td>The salt forms a very concentrated solution on the slug’s surface
so water leaves its body by osmosis.</td><td>1 mark
1 mark</td></tr>
<tr><td>2</td><td>
<table>
<tr><th></th><th>Diffusion</th><th>Osmosis</th><th>Active transport</th></tr>
<tr><td>active or passive?</td><td>passive</td><td>passive</td><td>active</td></tr>
<tr><td>which molecules move?</td><td>only small molecules can pass through partially permeable membrane</td><td>water molecules</td><td>specific molecules depending on carrier</td></tr>
<tr><td>requires special carrier proteins?</td><td>no</td><td>no</td><td>yes</td></tr>
</table>
</td><td>9 marks</td></tr>
<tr><td>3 a)</td><td>Diffusion</td><td>1 mark</td></tr>
<tr><td>3 b)</td><td>Neither</td><td>1 mark</td></tr>
<tr><td>3 c)</td><td>Osmosis</td><td>1 mark</td></tr>
<tr><td>4</td><td>The larger an organism, the smaller its surface area to volume ratio
and so, though it needs more materials to support the life processes in cells, it would have a relatively smaller surface area over which to absorb/exchange what it needs.
This would slow the rate of diffusion.
Special adaptations, such as alveoli in the lungs, increase the surface area and so increase the rate of diffusion.</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>5 a)</td><td>More than</td><td>1 mark</td></tr>
<tr><td>5 b)</td><td>To provide energy for the active transport of minerals like nitrates into the roots</td><td>1 mark</td></tr>
<tr><td>6 a)</td><td>It is a partially permeable membrane like cell membranes are.</td><td>1 mark</td></tr>
<tr><td>6 b)</td><td>Iodine/potassium iodide to test for starch
Benedict's test for fructose (because it is a reducing sugar)</td><td>1 mark
1 mark</td></tr>
<tr><td>6 c)</td><td>No reaction with the iodine/potassium iodide
Benedict's test would show a positive reaction (blue colour changes to yellow or orange-red precipitate).</td><td>1 mark
1 mark</td></tr>
<tr><td>6 d)</td><td>Fructose is a small molecule and so can diffuse through the membrane,
but starch is too large and cannot pass through.</td><td>1 mark
1 mark</td></tr>
<tr><td>7</td><td>The membranes control what enters and what leaves the organelle.
This means that different conditions can be set up in one organelle for a particular process than in a different organelle where something else happens.
This makes it possible for many different processes to go on in one cell at the same time.</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td></td><td>Total:</td><td>30 marks</td></tr>
</table>

B2e Nutrition

Page 66

1.

$$6CO_2 + 6H2O \xrightarrow[\text{light energy}]{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

2. CO_2 from air, H_2O from soil water, $C_6H_{12}O_6$ used in cells for respiration or converted to other chemicals for use in cells, O_2 released into air if not needed in respiration.

3. Any four from: as glucose for respiration; converted to sucrose for storage in fruits; converted to starch for storage; converted to cellulose to form cell walls; converted to oils for storage; converted to proteins for growth.

Page 68

1. Thin broad leaves, chlorophyll in cells, veins containing xylem tissue that transports water and mineral ions to the leaves and phloem tissue that takes products of photosynthesis to other parts of the plant, transparent epidermal cells, palisade cells tightly packed in a single layer near top of leaf, stomata to allow gases into and out of leaf, spongy mesophyll layer with large internal surface.

2. A large surface area helps to maximise the rate of diffusion, in this case diffusion of carbon dioxide into cells for photosynthesis and oxygen out of cells so that it can be released into the air.

3. Allows as much light through as possible to the chloroplasts in the palisade cells below.

Developing investigative skills, page 72

1. a) Oxygen is a waste product of photosynthesis. So the rate of production of oxygen is a good estimate of the rate of photosynthesis.

   b) With a glowing splint, because it is oxygen – the splint should relight.

2. a) Line graph should be shown, with distance on *x* axis and number of bubbles on *y* axis. Straight line of best fit drawn through the points.

   b) The graph shows that as distance increases the rate of bubble production decreases. This is because light energy is needed for the process of photosynthesis – as light decreases so the rate of photosynthesis decreases.

3. a) A filament light bulb releases heat energy as well as light energy. Heat also affects the rate of reaction, so the closer the lamp was to the plant, the greater the effect of heat on the reactions.

   b) Use a low-energy bulb that releases little heat, or place a transparent heat barrier (such as a thin water tank) between the lamp and the plant.

Page 73 (top)

1. Light intensity, carbon dioxide concentration, temperature

2. As light intensity increases, so the rate of photosynthesis increases because more energy is supplied to drive the process.

As carbon dioxide concentration increases, so the rate of photosynthesis increases because there is more reactant for the process.

As temperature increases, the rate of photosynthesis increases because the particles in the reaction including enzymes are moving faster and bump into each other more. There is a maximum temperature above which the rate of photosynthesis decreases because the enzymes that control the process start to become denatured.

3. The only part of the leaf that can photosynthesise is the green part where there is chlorophyll. So only in the green parts can glucose be produced. Starch is formed from glucose, so it is only formed in the green parts where photosynthesis has taken place.

Page 73 (bottom)

1. Plants make their own foods, and need to convert the carbohydrates made by photosynthesis into other substances, such as proteins, which contain additional elements.

2. a) Limited growth, lack of green colour in leaves

   b) Magnesium is needed to make chlorophyll, which is the green substance in plants.

3. a) Nitrogen is an essential element for making substances other than carbohydrates, such as proteins. Without proteins, the plant cannot make new cells so the plant will not grow well. It is also needed for making chlorophyll, so without nitrogen the plant will not be able to make as much of the green pigment.

   b) Without enough magnesium the plant will lose the green colour and become yellow. Any magnesium in the plant is transported to the new leaves, so that photosynthesis can continue there for making food for growth.

Page 74

1. a) The leaves of the plant with limited nitrogen are paler yellow than those of the plant with a lot of nitrogen.

   b) The plant with plenty of nitrogen is larger, bushier and has more leaves than the plant with limited nitrogen.

2. The leaf cells of the plant with limited nitrogen will contain less chlorophyll because nitrogen is needed to make this substance.

3. The plant with plenty of nitrogen is not only able to make more chlorophyll and therefore photosynthesise more and produce more carbohydrate, it also has sufficient nitrogen to convert some of that glucose into proteins. So it can make more new cells more rapidly than the plant with limited nitrogen, and so grow taller and bushier and produce more leaves.

4. When the crop plants grow they take in nitrogen from the soil and convert it to substances such as proteins and chlorophyll in the plant tissues. When the plant is harvested, the nitrogen in the tissues is taken as well. This leaves less nitrogen in the soil for the next crop. With a smaller amount of nitrogen in the soil, the new crop will not grow as well as the previous crop. Additional nitrogen, in the form of nitrogen-containing fertilisers, makes sure the new crop has sufficient nitrogen for rapid and healthy growth.

Page 76

1. More intense sunlight, so likely to make sufficient vitamin D naturally in skin and less dependent on vitamin D in diet

2. Higher latitude so less intense sunlight means less vitamin D produced in skin, and poor diet would mean increased risk of too little vitamin D in diet

3. Cod liver oil is formed from liver which is a good source of vitamin D.

4. If diets include more sources of vitamin D, such as fish, eggs, cheese and milk, then the risk of vitamin D deficiency is reduced.

5. Lack of light on the skin means little chance of natural vitamin D production, and a vegetarian diet reduces the amount of vitamin D available in the diet. Vitamin D supplements in the diet can help to avoid the deficiency, but care must be taken not to take too much vitamin D over a long period as high levels in the body can be toxic. So supplements during the winter may be more advisable than supplements all the time.

Developing investigative skills, page 79

1. a) As the food burns, heat energy is released. The heat energy is transferred to the water molecules in the tube. The temperature in the water rises and is measured by the thermometer.

   b) Care is needed because of the burning food. There should be something below the apparatus that is not flammable (such as a heatproof mat) to catch anything that falls. The burning food should be held on a mounted needle or in tongs, and a heatproof glove used to hold the needle/tongs. The area should be kept clear of anything that is flammable, and there should be good ventilation to remove the fumes of burning.

2. a) Food 57.3 J/g; leaf 8.8 J/g

   b) So that you can compare the amount of energy in each food more easily.

3. Food/crisp

4. Seeds/nuts/food will provide the animal with chemical energy much more rapidly than eating leaves.

5. Not all of the heat energy released in burning is transferred to the water molecules, a lot escapes to the surrounding air. An enclosed set of apparatus (calorimeter) would increase the efficiency of transfer to the water molecules.

Page 80

1. Carbohydrates, proteins and fats.

2. a) USDA: Vegetables and grains; UK: Fruit and vegetables, and bread, rice, pasta and potatoes

   b) Vitamins, minerals, fibre and carbohydrates

   c) Food and drink high in fat and/or sugar

   d) To avoid taking in too much energy, which can lead to obesity

3. Any answers along the lines of: different people need different amounts of energy every day, for example active people need more than people who are seated for much of the day; men have a larger average body mass than women so will need more energy to support that extra tissue; some groups of people need more of a particular group of nutrients than others, for example, pregnant women need additional iron.

4. Food that contains more energy than the body uses is converted into body fat. High levels of body fat cause obesity, which is associated with many health problems.

Page 83

1. Sketch should show the following labels correctly attached to organs shown on the diagram:

- mouth, where food is broken down by physical digestion (chewing) and amylase enzyme starts digestion of starch in food
- oesophagus moves food from mouth to stomach by peristalsis
- stomach, where churning mixes food with protease enzymes and acid to start digestion of protein molecules
- small intestine, where alkaline bile neutralises the acid and enzymes from pancreas complete digestion of proteins, lipids and carbohydrates, and where digested food molecules are absorbed into the body
- large intestine, where water is absorbed from undigested food
- rectum, where faeces are held until they are egested through the anus
- liver, where bile is made and where some food molecules are assimilated
- gall bladder, where bile is stored until needed

- pancreas, where proteases, lipases and amylase are made, which pass to the small intestine

2. Egestion is the removal of undigested food from the alimentary canal – food that has never crossed the intestine wall into the body. Excretion is the removal of waste substances that have been produced inside the body.

3. Contraction of the circular muscles pushes the food bolus further along the alimentary canal.

Page 85

1. Chemical digestion uses chemicals (enzymes) to help break down large food molecules into smaller ones. Physical digestion is the chewing by the teeth to break large pieces of food into smaller ones before swallowing.

2. The digestive enzymes break down food molecules that are too large to cross the wall of the small intestine into smaller ones that can diffuse across cell membranes and so enter the body. If we did not have enzymes, we would not be able to absorb many nutrients from our food.

3. a) Amylase

   b) Maltose

4. a) The acid increases the acidity in the stomach, providing the right conditions for enzymes that digest food in the stomach.

   b) Bile neutralises the acidity of food from the stomach, providing the right conditions for enzymes that digest food in the small intestine. It also emulsifies fats, providing a larger surface area for lipase enzymes to work on.

Page 87

1. Long length; villi that cover the intestine wall increase the surface area; microvilli on surface of villi cells increase surface area for absorption even further; extensive blood supply removes absorbed food molecules quickly so maintaining a high concentration gradient for diffusion; lacteals in the villi carry absorbed lipid molecules away to the rest of the body.

2. Stores some molecules from absorbed food, vitamins A and D and iron; converts excess glucose to glycogen and stores it; breaks down excess amino acids

Worksheet B2e.3a

1. Fruit, vegetables, fibre

2. Fruit and vegetables are key sources of vitamins and minerals in the diet. Fibre is essential for healthy working of peristalsis in the alimentary canal, and prevention of constipation and related problems.

3. Any suitable answers, such as: doesn't identify which nutrients so can't tell whether you are ending up with lots of some and not enough of others; doesn't identify portion size; what if you don't like fruit and/or vegetables, what can you eat instead?

4. It includes all the main food groups, not just fruit and vegetables.

5. About one-third

6. Any suitable answer, such as: simple visual image easily translated into a meal on a plate, shows balance of food groups in diet, easy to substitute one food in a group for another

7. Any suitable answers, such as: what if you aren't eating a whole meal, doesn't apply well to snacks; difficult to apply to food eaten over whole day

8. Energy content; main food groups, i.e. fats, proteins and carbohydrates; saturated fats; sugars; fibre; sodium and salt equivalent

9. Energy content is the amount of energy in the food, so helps you see what energy you need to use to maintain an energy balance. Fats/lipids are needed but high saturated fat intake is associated with heart disease. Carbohydrates are needed for energy, but having too much as sugar is associated with a risk of

diabetes and obesity. Fibre is important for healthy working of alimentary canal. Sodium/salt equivalent is given because high levels in a diet may be a problem for people with heart disease.

10. It shows what proportion of the average daily adult intake of each of the risk food groups are in the food.

11. Any suitable answers, such as: lists of numbers are not easy to make sense of; takes time to add up all the information from all the labels on the foods, who will bother?

12. These are the key elements of food that can cause concern as noted in answer to question 9 (cals = energy) – a simplified way of displaying data from table.

13. It shows you how much you will get of each of the food groups that are of concern, so you can balance it with other foods with lower amounts of those during the rest of the day.

14. Any suitable answers, such as: do the people who need to look at the labelling; does everyone understand percentages; the guideline daily amount is an average, so may not be appropriate advice for everyone

15. Any suitable answers, such as: lots of different advice so confusing; few people take notice of food advice when eating

16. Any suitable answers that take into account trying to get a complex message across simply to different groups of people.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Photosynthesis is the formation of simple sugars (such as glucose) from the combination of water and carbon dioxide in the presence of light and chlorophyll.	1 mark 1 mark
1 b)	Photosynthesis produces simple carbohydrates that the plant then converts to other substances that it needs, including other carbohydrates (e.g. cellulose for cell walls, proteins, oils).	1 mark 1 mark
1 c)	Photosynthesis provides the carbohydrates that are converted to all the other substances a plant needs to form new plant tissue. Herbivores get their nutrition from eating plants and carnivores get their nutrition from eating herbivores (or other carnivores that have eaten herbivores). So all animals ultimately depend on plants for their nutrition.	1 mark 1 mark
2 a)	Ingestion in the mouth, where food enters the alimentary canal	2 marks
2 b)	Digestion in the mouth – physical by teeth, chemical by amylase; stomach – protease enzymes; small intestine – amylase, protease and lipase enzymes produced by the pancreas, also bile from liver via gall bladder to emulsify fats	2 marks
2 c)	Absorption in small intestine where digested food molecules can cross the cell membranes of the villi cells and into the blood	2 marks
2 d)	Assimilation by the liver, of glucose to form glycogen, vitamins A and D stored, excess amino acids broken down to form urea	2 marks
2 e)	Egestion through the anus at the end of the alimentary canal back into the environment	2 marks
3	A high concentration gradient and a large surface area to volume ratio maximise the rate of diffusion into and out of cells. A high concentration gradient for substances needed for photosynthesis is maintained by a thin leaf (so carbon dioxide doesn't have to travel far	1 mark 1 mark

	from air to chloroplast), and xylem (transporting water from root to leaf). A high concentration gradient for substances made during photosynthesis is maintained by a thin leaf (for oxygen diffusing out of cells into the air) and phloem (transporting sugars to rest of plant). The large surface to volume ratio is produced by the leaf being broad and thin, maximising surface area in relation to volume, and by the large internal surface area created by the spongy mesophyll.	1 mark 1 mark
4 a)	Vitamin A sources: liver, red/orange vegetables, butter, fish oil; needed for healthy vision and skin; Vitamin C sources: citrus fruit and green vegetables, potatoes; needed for healthy skin and gums and blood vessel linings; Vitamin D sources: fish, eggs, liver, cheese and milk; needed for strong bones and teeth	2 marks
4 b)	Calcium needed for strong bones and teeth, also blood clotting; iron needed for haemoglobin in red blood cells	1 mark 1 mark
4 c)	Water is needed in all cells because many reactions take place in watery cytoplasm.	1 mark 1 mark
4 d)	Fibre keeps undigested food in the alimentary canal bulky and soft, helping peristalsis to work efficiently. A low-fibre diet may increase the risk of bowel cancer.	1 mark 1 mark
5 a)	Starch is formed from glucose, which is the product of photosynthesis. If there is no photosynthesis, then no glucose will be produced and so no starch can be produced.	1 mark
5 b)	Place the plant in a dark place for a couple of days so that the starch in the plant/leaf is all used. This means any starch in the leaf at the end of the investigation has been produced by photosynthesis during the investigation.	1 mark 1 mark 1 mark
6	Physical digestion of food in the mouth breaks food pieces into smaller pieces, which makes them easier to swallow and increases their surface area to volume ratio, making it easier for enzymes to combine with more food molecules more quickly and so speed up the rate of digestion.	1 mark
7 a)	The surface of the small intestine is covered in villi and the surface of the villi cells are covered in microvilli. These greatly increase the surface area of the small intestine. As surface area is related to the rate of absorption by passive processes such as osmosis and diffusion, a large surface area means a greater rate of absorption of substances into the body from the small intestine.	1 mark 1 mark
7 b)	The single layer of cells means there is only a small distance over which substances need to travel to be absorbed into the villi and into the blood vessels that will carry them away to the rest of the body.	1 mark 1 mark
7 c)	The extensive blood supply means that the absorbed substances are rapidly carried away from the villi to other parts of the body, maintaining a steep concentration gradient across the small intestine wall to maximise the rate of diffusion and osmosis.	2 marks
7 d)	The lacteals carry lipid molecules away from the villi to other parts of the body, separate from the blood in which they would not easily dissolve.	2 marks
8 a)	i) Carbohydrates: cereal, banana, bread, honey/jam, beans, sugars in juices and squash, fruit, potatoes/rice, bagel, chocolate	1 mark

	ii) Proteins: milk, bacon, eggs, fish/meat, chicken, yoghurt iii) Lipids: milk, olive/sunflower spread, eggs, (possibly sauce), yoghurt iv) Vitamins and minerals: dairy for vitamin D and calcium, fish oil for vitamins A and D (if oily fish eaten), vegetables and fruit for vitamin C; green vegetables for iron v) Fibre in wholegrain cereals, wholegrain bread and vegetables	1 mark 1 mark 1 mark 1 mark
8 b)	Carbohydrates	1 mark
8 c)	They break down easily to glucose for use in respiration to produce energy during training.	1 mark
8 d)	Proteins may be greater to help with building more muscle.	1 mark 1 mark
8 e)	It contains too much energy. Most people do not use this amount of energy during one day. The excess energy in the diet would be laid down as fat in the body, leading to a risk of obesity and related health problems.	1 mark 1 mark
9 a)	The detail of the shape of the line on the graph is unimportant, as long as it shows an increase in rate from the baseline after sunrise, to a maximum in the afternoon, and a decrease to the baseline at sunset.	2 marks
9 b)	The increase after sunrise to the maximum should be labelled to indicate that light is a limiting factor (and possibly temperature which will also increase as the sun warms the air and land). At the maximum, light and temperature should be in excess, so carbon dioxide is most likely to limit the rate of photosynthesis. As the rate falls again, the controlling (limiting) factor is most likely to be light.	2 marks
10 a)	As night approaches, the light intensity falls below the level at which it limits the rate of photosynthesis and doesn't rise again until dawn. Keeping the lights on all night means that photosynthesis continues all night, so more food is made in the leaves and so the plants can grow faster and produce more tomatoes.	1 mark
10 b)	Temperature controls the rate of photosynthesis. So when it gets cold at night, the rate of photosynthesis will drop – closing the windows will help to keep the plants warmer. During the day, if the windows are not open, the temperature may get too high and so limit the rate of photosynthesis by affecting the activity of enzymes involved in the process.	1 mark
10 c)	Adding nutrients to the water makes sure the plants have sufficient nitrogen and magnesium to absorb for making chlorophyll and proteins, so maximising the rate of growth of the plants.	1 mark
11 a)	UK is shown as a pie chart, whereas the US is shown as a diagram Different ways of grouping foods and food types	1 mark 1 mark
11 b)	Different authorities have different ways of displaying things (or equiv.).	1 mark
11 c)	Student's own answer, with justifications. For example: UK because it is easier to see the proportions of different types of food and examples of the different types of food are given.	1 mark 1 mark
	Total:	64 marks

B2f Respiration

Developing investigative skills, page 97

1. Changes in temperature using the thermometer, release of carbon dioxide which will make the limewater milky or hydrogencarbonate indicator yellow.

2. The limewater turned milky indicating the release of carbon dioxide. The temperature increased from 15 to 19 °C. These changes would be expected during cellular respiration because some of the energy released would be heat energy, and both aerobic and anaerobic respiration in plants produce carbon dioxide.

3. You would need to repeat the experiment for the same length of time, with the same apparatus

Page 98

1. Inside cells

2. a), b) and c) Glucose (from digested food from alimentary canal via the blood) + oxygen (from air via lungs) + carbon dioxide (excreted through lungs) + water (used in cells or excreted through kidneys) (+ energy (transferred to other chemicals in cell processes))

   d) All water used in cells because the camel is much better than humans at using the water from respiration.

3. Aerobic respiration uses oxygen from the air.

Page 100

1. During vigorous exercise, they may not be able to get enough oxygen from the blood for all the energy they need for contracting. So the additional energy comes from anaerobic respiration.

2. Similarities: use glucose as substrate, produce energy, don't need oxygen

   Differences: animals produce lactic acid; plants produce ethanol and carbon dioxide

3. Inside germinating seeds where the cells may be too deep to get oxygen by diffusion, or where the seed is surrounded by water, which prevents oxygen from the air reaching the seed.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	Reactants: oxygen – enters body through breathing/respiratory system (lungs), travels to cells via circulatory system (blood); glucose – enters body via digestive system (small intestine), travels to cells via circulatory system (blood) Products: carbon dioxide enters circulatory system (blood), excreted through breathing/respiratory system (lungs); water often used in cells	5 marks

<table>
<tr><td>2</td><td>Any suitable table that shows these facts clearly:
<table>
<tr><th></th><th>Aerobic respiration</th><th>Anaerobic respiration</th></tr>
<tr><td>Similarities</td><td colspan="2">Use glucose as reactant
Release energy for cell processes</td></tr>
<tr><td>Differences</td><td>Always uses oxygen
Produces carbon dioxide and water
Releases a lot of energy from each glucose molecule</td><td>Oxygen is not needed
Produces either lactic acid (animals) or ethanol and carbon dioxide (plants)
Releases a little energy from each glucose molecule</td></tr>
</table></td><td>8 marks</td></tr>
<tr><td>3 a)</td><td>Tube linked to germinating peas: limewater would have turned milky colour.
Tube linked to the boiled peas: limewater would not have changed.</td><td>1 mark
1 mark</td></tr>
<tr><td>3 b)</td><td>The germinating seeds are respiring, breaking down food molecules in aerobic respiration and releasing carbon dioxide as a waste product.
The carbon dioxide turns the limewater milky.
The boiled peas would be dead, so they would not be respiring and no carbon dioxide would be produced.
So the limewater in this apparatus would not change colour.</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>4</td><td>At the start the muscles will more probably use the oxygen available for aerobic respiration.
Oxygen levels will drop over time, because the whale cannot breathe air again until it returns to the surface.
During this time, the muscle cells will respire anaerobically, to provide the energy needed for swimming.</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td>5 a)</td><td>One biscuit lasts one hour, so eight biscuits last eight hours.</td><td>1 mark</td></tr>
<tr><td>5 b)</td><td>Eight biscuits = c. 1 mole of glucose which releases only c. 150 kJ of energy when respired anaerobically.
If 8 hours aerobically uses c. 2900 kJ of energy, then 150 kJ of energy would last 150/2900 $\times$ 8 = 0.4 hours, which is about 25 minutes.</td><td>1 mark
1 mark</td></tr>
<tr><td>5 c)</td><td>The time for anaerobic respiration is much less
because the glucose is only partly broken down during anaerobic respiration,
so releasing much less energy,
and more fully broken down during aerobic respiration and so releasing much more energy.</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td></td><td>Total:</td><td>29 marks</td></tr>
</table>

B2g Gas exchange

Page 105

1. All the time, because they continually need energy for making new substances and other life processes

2. When the light intensity is high enough/during daylight hours, because photosynthesis needs energy from sunlight

3. It is the point for a plant when the rate of photosynthesis/oxygen production/carbon dioxide uptake is the same as the rate of respiration/carbon dioxide production/oxygen uptake

4. From the graph, between the hours of about 9:00 and 14:00 when the rate of photosynthesis exceeds the rate of respiration

Developing investigative skills, page 106

1. Plan should include:

- piece of *Elodea* (pondweed) or similar plant in beaker of pond water with added hydrogencarbonate indicator
- at least two sets of identical apparatus, for use in different light regimes, or the same apparatus used in different light regimes starting with fresh pond water and indicator each time
- as soon as apparatus set up, placed in appropriate light regime, including at minimum bright light and dark (such as in dark cupboard)
- apparatus left for sufficient time (e.g. 20 minutes) without disturbance, to allow for photosynthesis and respiration to have an effect on indicator.

2. a) The colour of the indicator turned from red-orange to purple.

b) The colour of the indicator turned from red-orange to yellow.

3. The solution was becoming more acidic, because carbon dioxide concentration in the water was increasing. This suggests that the plant was releasing carbon dioxide into the water from respiration.

4. The solution was becoming more alkaline because carbon dioxide was being taken out of the water by the plant for photosynthesis.

5. Respiration is also happening, while photosynthesis is taking place, but no carbon dioxide is added to the solution because the cells use it for photosynthesis.

6. It would mean no carbon dioxide being added or removed from the solution – the plant is at its compensation point.

7. To find the compensation point, you need to have several repeats of the apparatus, and be able to control the light intensity. Then you could find the intensity at which there was no change in colour of the indicator from red-orange, which means the solution remains at neutral pH and there is no net uptake or release of carbon dioxide.

Page 107

1. Carbon dioxide is soluble and acidic, so when more gas is being produced, such as during respiration, the solution becomes more acidic. When carbon dioxide is removed from the solution, such as during photosynthesis, the solution becomes less acidic.

2. Sketch should show: thin leaf to maximise area for gas exchange and minimise distance that gases have to diffuse between air and photosynthesising (palisade) cells; spongy mesophyll cells and air spaces connected to air via stomata, to maximise the internal surface area for gas exchange; stomata that control gases moving into and out of leaf

3. The gas molecules are small and so can diffuse across cell membranes, into cytoplasm and into chloroplasts. The rate of photosynthesis is, in part, controlled by the rate of diffusion of gases between the chloroplasts and air.

Page 109

1. List and functions as follows:

- Trachea – carries air from mouth down to lungs
- bronchi – the two large divisions of the trachea as it reaches the lungs, supported with rings of cartilage to prevent collapse during breathing
- bronchioles – the fine tubes in the lungs that carry air to alveoli
- alveoli – the bulges of the air sac, which have large surface area and are very thin for efficient diffusion of gases

- pleural – membranes that surround the lungs are involved in ventilation
- ribs and intercostal muscles – protect the lungs but also help expand the volume of the thorax during forced or deep breathing
- diaphragm – tough tendinous sheet surrounded by muscle below lungs that controls relaxed breathing

2. Gas exchange is the movement of gases into and out of the cells of the body. Ventilation (breathing) is the movement of air into and out of the lungs.

Page 113

1. a) Inhalation: The muscles surrounding the diaphragm contract causing the diaphragm to flatten, pulling downwards on the thorax; the intercostal muscles contract lifting the ribs out and up; these actions increase the volume of the thorax, causing the volume of the lungs to increase. This decreases the pressure inside the lungs, and so draws air into the lungs.

   b) Exhalation: The muscles surrounding the diaphragm relax, and the diaphragm is pushed upwards by the organs below it; the intercostal muscles relax, so the ribs fall back and down; both actions reduce the volume of the thorax, so reducing the volume of the lungs. This increases the pressure inside the lungs compared with the air outside, so this pushes air out of the lungs.

2. a) Just two: the wall of the alveolus and the wall of the blood capillary

   This short distance is important so gases can easily move between the alveoli and the blood. Another way of looking at it is that the short distance increases the concentration gradient.

   b) To ensure that oxygen rapidly diffuses from the area of high concentration, in the alveoli, to the area of low concentration, in the blood.

   Don't forget that there is also a concentration gradient for carbon dioxide.

3. Sketch similar to Fig. 2.75 on page 112 of the Student Book, with annotations showing: thin lining of alveolar wall and wall of capillary allows rapid diffusion; high concentration gradients for gases between blood and air in alveolus due to continuous blood flow through capillary and ventilation of alveolus (lungs); large area of contact between capillary and alveolus, maximising area over which diffusion can occur.

Developing investigative skills, page 113

1. Plan should include:

- several people (because of variation between individuals)
- some form of exercise that can be controlled, so that each individual is exercising as much as the others
- stopwatch to measure number of breaths in a particular time
- spirometer to measure depth of breathing – the people being tested will have to be instructed to breathe normally because forced breaths easily increase volumes
- breathing rate and volume need to be measured immediately after the 2 minutes.

2. Test subjects need to be reasonably fit, so that exercise is not a risk to health, and should be wearing suitable clothing for exercise. Exercise ideally should be carried out in open space or in a gym where the risks of tripping over obstacles is minimised.

3. First check for outliers (errors in measurements), such as the volume of breath for C at rest which seems much higher than the others. Then, ignoring outliers, calculate the average for each factor in the two conditions.

Page 117 (top)

1. So it is easier to compare the values, because there will have been different numbers of mothers/babies in each group; makes it easier to see any pattern in the results

2. The chart shows that even some non-smoking mothers had low-birthweight babies. However, the proportion goes up as the number of cigarettes per day goes up, and heavy smokers have more than twice the proportion of low-birthweight babies as the non-smokers.

3. The conclusion is incorrect, because some babies born to non-smoking women have a low birth weight, so there must be other causes. However, the chart does show that increasing levels of smoking increases the risk of having a low-birthweight baby in this sample of women.

A better conclusion would say something like: In this sample, women who smoked a little during pregnancy had an increased risk of having a low-birthweight baby, and those that smoked a lot had an even greater risk.

4. This study shows the results for Canadian women only, and there may be other factors in this population that could produce this result. By comparing many studies from different countries, with

women who have different lifestyles, it can balance out the effect of other factors. So any remaining relationship between birth weight and smoking becomes more definite and reliable.

5. Carbon monoxide could have this effect, by reducing the amount of oxygen that gets to the fetus's cells. Since oxygen is needed for respiration, if the amount of oxygen is reduced, the rate of respiration will be reduced, which will reduce the rate at which energy is released that can be used for building new cells (growth).

Page 117 (bottom)

1. Addiction, nervous system; bronchitis, respiratory system; emphysema, respiratory system; cancer, any part of the body but mainly respiratory system; stroke/heart attack, circulatory system

2. Carcinogenic means cancer-causing/a chemical that can cause cells to become cancerous so they grow and divide without stopping.

3. Emphysema is the breaking down of some of the surface of the alveoli. This leaves a smaller area for gas exchange/absorption of oxygen. So the person may not get enough oxygen for activity. Additional oxygen in the gas they breathe can help to get more oxygen into their blood and so to their cells.

4. Small molecules from the smoke, such as nicotine and carbon monoxide, can diffuse into the blood and be carried around to all parts of the body.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	When the light is switched on, the proportion of oxygen dissolved in the water increases. This is because more oxygen is released by the plant from photosynthesis than is used in respiration.	1 mark 1 mark
1 b)	When the light was switched off, the proportion of dissolved oxygen in the water decreased. This is because no oxygen was being released by the plant from photosynthesis, and the oxygen that was available was being used in respiration.	1 mark 1 mark
2 a)	Percentage of oxygen is less in exhaled air than inhaled air because oxygen in the body is used for respiration.	1 mark 1 mark
2 b)	Percentage of carbon dioxide is greater in exhaled air than inhaled because the body produces carbon dioxide in respiration.	1 mark 1 mark
2 c)	Percentage of nitrogen doesn't change because it isn't used by the body.	1 mark 1 mark

3 a)	i) The balloons will expand.	1 mark
	This is because pulling down on the rubber diaphragm increases the volume inside the bell jar and so decreases the pressure.	1 mark
	This pulls on the balloons, increasing their volume and decreasing their pressure,	1 mark
	so air will be pulled into the balloons through the pipe.	1 mark
	ii) The balloons will collapse.	1 mark
	This is because the volume inside the bell jar has decreased, so increasing the pressure.	1 mark
	This pushes on the balloons, increasing the pressure inside them,	1 mark
	so air will be pushed out of the balloons into the air.	1 mark
3 b)	The ribs and intercostal muscles are not modelled.	1 mark
	During deeper or forced breathing the external muscles contract, pulling the ribs out and upwards increasing the volume of the thorax even further,	1 mark
	and increasing the volume of air pulled into the lungs.	1 mark
	On exhalation, the muscles relax,	1 mark
	letting the ribs move down and in, reducing the volume of the thorax,	1 mark
	and resulting in a larger outbreath.	1 mark
4	The statement only refers to net production.	1 mark
	During the day, when there is light, the plant photosynthesises as well as respires.	1 mark
	So it releases more oxygen from photosynthesis than it uses in respiration, but all the carbon dioxide from respiration is used in photosynthesis.	1 mark
	At night, when it is dark, there is no photosynthesis but respiration continues.	1 mark
	So the plant takes in oxygen and releases carbon dioxide.	1 mark
5 a)	Diffusion is the net movement of molecules from an area of their higher concentration to an area of their lower concentration as a result of random movement.	1 mark
	Gas exchange is the movement of gases into and out of the body.	1 mark
5 b)	Gas exchange occurs as a result of diffusion of oxygen and carbon dioxide across cell surfaces, into and out of the body.	1 mark
	In plants this is in the leaf, in humans it is across the surface of alveoli in the lungs.	1 mark
	For the following, any points up to a max of 3 marks: Tissue adaptations: There is a thin layer of cells between the air and the inside of the organism. This reduces the distance that gases have to pass through cells to get into or out of the body, so the rate of diffusion is as fast as possible.	Max 3 marks: 1 mark
	Organ adaptations: – The surface area where gas exchange occurs (i.e. mesophyll cell surfaces, alveolar walls) is maximised so that diffusion can occur as	1 mark

	rapidly as possible. – The leaf is broad and flat, and has stomata that let air into the leaf, so reducing the distance across which diffusion between the air and leaf cells occurs, which maximises the rate of diffusion of gases across leaf surfaces. – The lungs have an extensive blood supply that continually transports carbon dioxide from the body cells to the lungs and oxygen from the lungs to the body cells. The continual flow of blood through the capillaries maximises the concentration gradient between alveolar air and blood, which increases the rate of diffusion.	1 mark 1 mark
6	Tobacco smoke enters the lungs during smoking, but there is no obvious direct contact with other parts of the body such as the circulation. We now know that chemicals from smoke, including carbon monoxide, enter the blood vessels in the lungs and are carried around the body. Some of these chemicals cause narrowing of blood vessels and increased blood pressure, and others cause cholesterol to build up inside blood vessels, narrowing them further and increasing the risk of blood clots that can block blood vessels.	1 mark 1 mark 1 mark 1 mark
7	The compensation point of a plant is when the rate of photosynthesis and the rate of respiration are equal. This is when the amount of sugar produced from photosynthesis is the same as the amount broken down in respiration. When the rate of photosynthesis is greater than at the compensation point, more sugars are made. This means there are more sugars for use for other purposes than the basic level of respiration needed to release energy to keep cells alive. So the more time that a plant is above the compensation point, the faster it can make new cells and grow.	1 mark 1 mark 1 mark 1 mark
	Total:	44 marks

B2h Transport

Page 125

1. Over the distance of several cells diffusion and osmosis work too slowly to supply substances the cell needs to carry out all the life processes as quickly as needed.

2. Xylem tubes carry water and dissolved substances from the roots to other parts of the plant including the leaves.

3. Phloem cells carry dissolved food materials, such as sucrose and amino acids, from the leaves where they are formed to other parts of the plants that use them for life processes or where they will be stored.

Page 126

1. Osmosis

2. Diagram should include annotations at the appropriate point, such as: soil water has higher concentration of water molecules than cytoplasm of cells in the root; water molecules enter root hair cells by osmosis; water molecules pass from cell to neighbouring cell by osmosis until they reach the xylem.

Developing investigative skills, page 128

1. In each case you would need two potometers set up as identically as possible, or run the investigation twice with the same equipment.

   a) Take measurements at a low temperature, and also at a higher temperature (for example, with a heater nearby, but below 40 °C when damage may start to occur to proteins/enzymes), keeping all other conditions identical.

   b) Take measurements at a low light intensity (such as with curtains/blinds closed), and also at a high light intensity (with curtains/blinds open), keeping all other conditions identical.

   c) Take measurements in still air conditions, and also in windy conditions (such as using a fan), keeping all other conditions identical.

   d) Take measurements in dry air, and also in humid air (such as with humidifier nearby), keeping all other conditions identical.

2. a) Moving air/sunlight with hot/moving air/sunlight so that heat/temperature is the only factor that differs.

   b) Moving air/sunlight compared with moving air/dark cupboard, or still air/sunlight with still air/dark cupboard, so that only the factor of light intensity differs.

   c) Compare still air/sunlight with moving air/sunlight, or compare still air/dark cupboard with moving air/dark cupboard, because light intensity is the same in both and only the factor of wind speed differs.

3. a) The rate of transpiration increases with higher temperature because the bubble moved 5 cm much more quickly (54 seconds for hot/moving/sunlight compared with 75 seconds with normal/moving/sunlight).

   b) The rate of transpiration is faster in higher light intensity because the bubble moved 5 cm much more quickly (still: 135 seconds in light compared with 257 seconds in dark; moving air: 75 seconds in light compared with 122 in dark).

   c) The rate of transpiration is faster when wind speed is greater because the bubble moved 5 cm much more quickly (light: 75 seconds in moving air compared with 135 seconds in still air; dark: 122 seconds in moving air compared with 257 seconds in still air).

4. As water is transpired from the leaf, more water is drawn into the leaf from the stem, and more water is then drawn into the stem from the capillary tubing. The bubble moves with the water, so the movement of the bubble indicates how much water has been taken up by the shoot.

5. Apart from a fault in the connection between the shoot and the tubing, some water is used in respiration in the leaves. (But this is usually minimal over the time of the experiment.)

6. The conclusions are based on comparing two results in each case. Carrying out repeats with the same shoot, and with shoots from the same plant, in each set of conditions would make it possible to identify any abnormal results and average variation, to produce more reliable conclusions.

Page 129

1. Diagram should include annotations at the appropriate point, such as: water molecules evaporate from surfaces of spongy mesophyll cells into air spaces; water molecules from air spaces move into and out through stomata into the air – diffusion (net movement) usually from inside leaf to outside; osmosis causes water molecules to move from xylem into neighbouring leaf cells, and then from cell to cell until they reach a photosynthesising cell or a spongy mesophyll cell; transpiration is the evaporation of water from a leaf.

2. Closing stomata reduces diffusion of water molecules out of the leaf. At night, oxygen is not needed for photosynthesis, so keeping stomata open would lose water unnecessarily.

3. a) When temperature is higher, particles move faster, so water molecules will diffuse out of the leaf more quickly.

b) When air humidity is low, there is a low concentration of water molecules in the air, so more water molecules will move out of the stomata into the air than are moving from the air into the leaf. This means the rate of transpiration will be faster.

b) When air humidity is low, there is a low concentration of water molecules in the air, so more water particles will move out of the stomata into the air than are moving from the air into the leaf. This means the rate of transpiration will be faster.

Page 131

1. Haemoglobin binds with oxygen when it is at high concentration such as in the lungs, and releases oxygen when it is at low concentration, such as in respiring tissues where the oxygen has reacted with glucose to produce carbon dioxide and water.

2. Breathing might become more rapid because with each breath the haemoglobin is combining with less oxygen than the body is used to. So it will deliver less oxygen to cells and the body response will be to increase breathing rate and depth.

3. More red blood cells in a given volume of blood means there will be more haemoglobin in that volume. More haemoglobin can combine with more oxygen, so each cm^3 of blood will carry more oxygen and deliver more oxygen to the body cells.

4. Training at high altitude for several weeks will cause the red blood cell count to increase. This will increase the oxygen-carrying capacity of the blood. When the athlete then competes at low altitude, their blood will be delivering more oxygen to their muscle cells than if they had trained at low altitude. So their muscles will be able to work harder aerobically than after low-altitude training.

Page 133

1.

Blood component	Function
Plasma	carries dissolved substances, such as carbon dioxide, glucose, urea and hormones also transfers heat energy from warmer to cooler parts of the body
Red blood cell	carries oxygen
White blood cell	protects against infection
Platelet	cause blood clots to form when a blood vessel is damaged

2. The biconcave disc shape increases surface area to volume ratio, so rate of diffusion of oxygen into and out of the cell is maximised. Haemoglobin inside the cell binds with oxygen when oxygen concentration is high and releases oxygen when oxygen concentration is low. The cell has no nucleus, so there is as much room as possible for haemoglobin. The cell has a flexible shape so it can squeeze through the smallest capillaries and reach all tissues.

3. Phagocytes engulf pathogens inside the body and destroy them. Lymphocytes produce antibodies that attach to the pathogens, either attracting phagocytes or causing the pathogens to break open and die. This all helps to prevent pathogens causing damage when they infect us.

4. Damage to a blood vessel can create an easy route of infection into the body. So forming a blood clot where there is damage, as quickly as possible, helps to reduce the risk of infection.

Answers

Page 136

1. a) Renal arteries

b) Aorta

c) Hepatic veins

2. Arteries are large vessels with thick, elastic muscular walls; capillaries are tiny blood vessels with very thin walls that are often only one cell thick; veins are large vessels with a large lumen and valves to prevent backflow of blood.

3. The walls stretch as blood enters them, and slowly recoil as the blood flows through, balancing out the pressure so that the rate of change in pressure is reduced.

Page 139

1. Vena cava, right atrium, right ventricle, pulmonary artery, pulmonary vein, left atrium, left ventricle, aorta

2. Valves between the ventricles and atria, and at the base of the blood vessels leaving the heart close when the heart is relaxing, and so prevent blood moving in the wrong direction

3. Heart rate increases with increasing level of exercise so that the blood is carried round the body faster and can carry oxygen from the lungs more quickly to the muscle cells, glucose from the alimentary canal (or released from liver cells) to the muscle cells, and carry carbon dioxide from the muscle cells more quickly to the lungs.

Developing investigative skills, page 140

1. a) Allowing exercise to continue for 2 minutes before taking heart rate gives time for the heart rate to adjust to conditions inside the body as a result of the changed level of exercise.

   b) Allowing a long enough time to rest between exercise levels gives the heart time to recover from the previous exercise and conditions inside the body to return to a resting state. So all tests are starting from the same base point.

2. The data show that heart rate increases from the resting rate as the level of exercise increases.

3. The data come from one subject during one set of tests. The investigation should be repeated several times with the same subject, to check that none of the measurements are anomalous, and to average the results because heart rate varies a lot even in the same person. The investigation should also be repeated with several other test subjects, to make sure the results apply generally and are not just the effect of the individual.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	The flatworm is very thin, so none of its cells is very far from the surrounding environment. So diffusion can supply all the substances its cells need fast enough for life processes to continue at a sufficient rate.	1 mark 1 mark
2 a)	They carry blood that flows from the heart to the body.	1 mark
2 b)	They carry blood that is flowing from body tissues to the heart.	1 mark
2 c)	Blood in the arteries is closer to the heart, which generates large pressures when the heart pumps blood out. As blood passes through the arteries and capillaries it loses pressure due to friction with the blood vessel walls.	1 mark 1 mark
2 d)	The thick muscular and elastic walls prevent rupturing when the pulse of blood increases blood pressure. As the heart relaxes and blood pressure falls, the recoil of the elastic walls helps to maintain the pressure of blood in the artery and even-out the pulse a bit.	1 mark 1 mark

2 e)	Veins have a large lumen that allows blood to flow easily back to the heart. Valves in the vein prevent backflow of the blood when surrounding muscles contract, so that the blood can only flow towards the heart.	1 mark 1 mark
3 a)	The evaporation of water from cell surfaces in the leaf of a plant	1 mark
3 b)	Xylem vessels in the veins	1 mark
3 c)	Xylem vessels are long tubes with no cell contents through which water passes easily. They continue from the root, through the stem to all parts of the plant including the leaves.	1 mark 1 mark
3 d)	In transpiration, water evaporates from the leaves of the celery which reduces the concentration of water in the cytoplasm of leaf cells, so water molecules move out of the xylem in the vascular bundles by osmosis. This causes a transpiration stream to be set up in the xylem, which draws water up from the base of the stalk. As the colouring is dissolved in the water, it is carried with the water up the xylem and into the leaves.	1 mark 1 mark 1 mark 1 mark
4 a)	They help in the formation of blood clots by causing the formation of fibrin where a blood vessel is damaged which traps blood cells to block the damaged area.	1 mark 1 mark
4 b)	It stops large amounts of blood escaping from the blood vessel and prevents pathogens getting in the body where they can cause illness.	1 mark 1 mark
4 c)	It will stop blood reaching cells beyond the clot, which will prevent cells getting oxygen and sugars needed for respiration, so the cells may die.	1 mark 1 mark 1 mark
4 d)	Aspirin prevents platelets from functioning and producing clots that could cause thrombosis.	1 mark
5	Red blood cells contain haemoglobin, which carries oxygen around the body. If the red blood cell count is lower than usual, the amount of oxygen that can be carried by the blood will be reduced. So the rate at which oxygen can be supplied to cells is reduced, so respiration in the cells will be slower. Respiration releases energy for all cell processes, including activity, so the cells of an anaemic person will not be able to supply energy as quickly as normal and they will feel tired more rapidly.	1 mark 1 mark 1 mark 1 mark
6	The leaves of the plant on the windowsill receive more light than those on the shelf, so the stomata in the leaves of the windowsill plant will be open wider so that photosynthesis can continue as quickly as possible. Wide stomata allow water molecules to diffuse out of the air spaces in the leaves more quickly. If the rate at which water is lost from the leaves is greater than the rate at which water is taken in from the soil, the cells in the plant will become	1 mark 1 mark 1 mark 1 mark

	flaccid causing the plant to wilt. (The temperature of the air around the windowsill plant and the temperature of its leaves are also likely to be higher than for the shaded plant, increasing the rate of transpiration for the light plant compared with the shaded plant.)	
7	The muscle in the left ventricle wall is much thicker than in the right ventricle wall, so it can contract more strongly and create a greater pressure. Blood from the right ventricle goes only to the lungs, where a high pressure would damage the capillaries that flow past the alveoli. Blood from the left ventricle will eventually travel around the body, through capillaries in organs, before returning to the heart, so a much larger initial pressure is needed to help it move this distance.	1 mark 1 mark 1 mark 1 mark
	Total:	38 marks

B2i Excretion

Page 147

1. The main organ of excretion is the leaf, because this is where the gaseous waste products of photosynthesis and respiration are excreted from the plant into the environment.

2. Lungs – carbon dioxide from respiration excreted from body

Skin – water and salts excreted from body

Kidneys – urea and other waste products in excess such as salts and water

3.

Structure	**Function**
Kidneys	produce urine by filtering waste substances from the blood
Ureters	carry urine from kidneys to bladder
Bladder	stores urine until it is released to the environment
Urethra	short tube linking bladder to environment

Page 150

1. Blood in glomerulus, nephron (Bowman's capsule, proximal convoluted tubule, loop of Henlé, distal convoluted tubule, collecting duct), pelvis of kidney, ureter, bladder, urethra

2. a) Bowman's capsule (in conjunction with glomerulus of blood capillaries)

b) Proximal convoluted tubule for most substances, also collecting duct for additional water

3. a) Glucose b) Active transport

Page 151

1. Osmoregulation is the control of the concentration of water in the blood.

2. a) ADH

b) Pituitary gland in brain

c) Cells of the collecting ducts in kidneys

3. ADH makes collecting duct walls more permeable to water, so more water is reabsorbed from the filtrate, making concentrated urine.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Excretion is the removal from the body of waste substances from metabolic reactions in cells.	1 mark
1 b)	i) Carbon dioxide and oxygen through stomata in leaves	1 mark
	ii) carbon dioxide in lungs,	1 mark
	sweat (water and salts) from skin,	1 mark
	urea and excess substances in the blood from the kidneys	1 mark
2	The wall of the glomerulus and Bowman's capsule are both very thin (one cell thick)	1 mark
	and have gaps between the cells.	1 mark
	This makes it easier for small molecules to be forced out of the blood and into the nephron to form the filtrate.	1 mark
3 a)	Selective reabsorption is the reabsorption of some molecules more than others.	1 mark
3 b)	Glucose is reabsorbed by active transport.	1 mark
	Water is reabsorbed by osmosis.	1 mark
3 c)	Glucose reabsorption would stop because active transport requires energy	1 mark
	from respiration in living cells.	1 mark
	Osmosis might continue because it is a passive process.	1 mark
3 d)	Glucose is essential in the body for cellular respiration.	1 mark
	If the kidneys relied just on diffusion for reabsorbing glucose, much would be lost in the urine.	1 mark
	Selective reabsorption takes back into the blood all the glucose that is in the filtrate, so that the body retains as much glucose as possible.	1 mark
4	When dehydrated (hot sunny day)	1 mark
	ADH makes the wall of the collecting duct more permeable	1 mark
	and more water is reabsorbed from the filtrate back into the blood to help prevent dehydration.	1 mark
5	Osmoregulation controls the concentration of water in the blood.	1 mark
	As water moves easily by osmosis, this also controls the concentration of water in all the cells that the blood passes as it circulates round the body.	1 mark
	If water concentration in cells falls too low, this affects reactions in cells and risks damaging the cells.	1 mark
	If water concentration in cells increases too much, there is a risk of the cells bursting as they do not have a strong cell wall to resist expansion.	1 mark
	Total:	24 marks

B2j Coordination and response

Page 158

1. An organism senses a stimulus (a change in the environment) using receptor cells. It responds to the stimulus using effector cells, such as muscle cells.

2. A tropism is a growth response of a plant to a stimulus.

3. a) Shoots grow towards light.

b) Roots grow in the direction of the force of gravity.

4. Auxin is produced in the tip of the growing shoot and diffuses down the shoot. Auxin on the bright/light side of the shoot moves across the shoot to the darker side as it diffuses down the shoot. Cells on the dark side of the shoot elongate more than the cells on the light side of the shoot, so the shoot starts to bend as it grows so that the tip is pointing towards the light.

Developing investigative skills, page 158

1. The box should be set up near to a strong light source, so that the light entering the box is clearly one-sided. The seeds should be kept moist, but not wet, during germination and as the seedlings grow. Growth could be measured as angle between tip of shoot and base for quantitative data, or using photographic evidence for qualitative data.

2. The control needs to be set up in exactly the same conditions as the test apparatus, but with light reaching the shoots equally from all directions (e.g. with the top of the box removed and an overhead light).

3. The seedlings in the windowed box should have grown so that their tips are heading towards the one-sided light (i.e. grown at an angle towards the light, while the control shoots should grow straight up).

4. Plants will need to be grown in water so that the roots can be exposed to light (e.g. large bulbs such as hyacinth, grown suspended over water). Then two similar plants will need setting up so one has roots exposed to one-sided light and the other to light all around the roots. Growth over a period of several weeks may be needed to show if the roots in one-sided light grow in a particular direction in relation to the light, compared with the all-around-light roots.

Page 163

1. Sketch should show that receptor cells are joined to nerves that carry electrical impulses to the central nervous system, and that the central nervous system is joined to nerves that carry electrical impulses to the effector cells.

2. a) The cornea is transparent so light passes through it easily into the eye.

b) The pupil is a hole surrounded by the iris, which controls the amount of light that passes through the iris to the back of the eye.

c) The retina contains the light-sensitive cells that respond to light. The retina is also very dark, to absorb as much light as possible.

3. As light intensity increases, the pupil gets smaller, reducing the amount of light that can enter the eye. This change happens because the radial muscle in the iris relaxes and circular muscle contracts. As light intensity decreases, the pupil gets larger, increasing the amount of light that can enter the eye. This change happens because the radial muscle in the iris contracts and circular muscle relaxes.

4. Light entering the eye from a near object needs to be refracted more than light from a distant object in order to focus it on the retina. The ciliary muscles that form a ring around the ligaments contract, which reduces the tension on the ligaments attached to the lens. This allows the lens to become thicker and more rounded, which increases its focusing power.

Page 165

1. A reflex response is a simple response of receptor→nerve→spinal cord→nerve→effector, which does not usually include the brain. This makes it possible to respond to a stimulus very quickly. Reflex responses are usually important in survival, for example to protect you from touching something dangerous, or blinking to protect the eye if something comes toward it.

2. Heat causes the receptor cells in the skin to respond. The receptor cells cause nerve cells (sensory neurones) to send electrical impulses to the spinal cord. The nerve cells pass the electrical impulses to nerve cells in the spinal cord (relay neurones), which pass the electrical impulses to nerve cells in the nerves leading to the arm muscles (motor neurones). These nerve cells pass the electrical impulses to the effector cells in the muscles, which cause the muscle cells to contract and move the hand away from the heat.

Page 166

1. Homeostasis is the maintenance of conditions inside the body within limits that allow cells to work efficiently.

2. Control of core body temperature; control of concentration of water in the blood

3. Skin blood vessels dilate when the core body temperature is too high. This allows heat energy carried by the blood to reach the skin surface more easily and so be transferred to the environment more rapidly. Skin blood vessels constrict when the core body temperature falls too low. This reduces blood flow to near the skin's surface, so heat energy cannot be transferred as easily to the skin surface and so cannot be transferred to the environment as quickly. This keep more heat energy within the body.

Developing investigative skills, page 167

1. The hot water in the tube is similar to the heat inside the human body. The wet towel models sweating skin on the surface of the hot body.

2. Another tube set up identically, with hot water, etc. but with a dry paper towel surrounding it.

3. Graph should have time on the *x*-axis and temperature on the *y*-axis, with both sets of points drawn on the same axes and clearly labelled. Each set of points should be joined by straight lines. There should be a comment about the outlier at 10 minutes of the dry towel.

4. The graph shows that temperature decreased in both tubes over time, but that it decreased faster in the tube surrounded by the wet towel compared with the tube surrounded by the dry towel.

5. Heat transfer from the hot water in the tube to the environment is faster when wrapped in a wet towel compared with a dry towel.

6. Heat energy is transferred from the water in the tube to the water in the towel, increasing their energy and allowing those water molecules to evaporate more quickly. As the water molecules evaporate into the air, they take the energy with them, so the tube cools down.

Page 169 (top)

1. Homeostasis is the regulation of conditions inside the body so that they remain fairly constant; so the concentration of blood glucose is kept within a small range.

2. Insulin is released from the pancreas when blood glucose concentration is high. It causes muscle and liver cells to take in glucose and convert it to glycogen for storage, so that blood glucose concentration falls.

3. The more insulin they inject the more glucose will be taken up by cells, so they have to make sure that blood glucose concentration won't fall too low, because that is dangerous.

4. Exercise needs energy from respiration, and that is supplied by the breakdown of glucose in muscle cells. This will mean that blood glucose concentration falls because the glucose will move down its concentration gradient into the muscle cells. With a lower blood glucose concentration, less insulin is needed in the blood.

Page 169 (bottom)

1. a) A chemical messenger in the body, that produces a change in the activity of some cells

   b) Glands that secrete hormones

   c) Organs that contain cells which are affected by hormones

2.

Hormone	Where produced	Effects
ADH	pituitary	increases permeability of collecting ducts in kidneys to water
adrenaline	adrenal glands	prepares body for action, e.g. increases heart rate, increases breathing rate, dilates pupils, causes glucose to be released into blood
insulin	pancreas	causes liver and muscle cells to remove glucose from blood
testosterone	testes	produces secondary sexual characteristics in boys and needed for sperm production

End of Topic Questions mark scheme

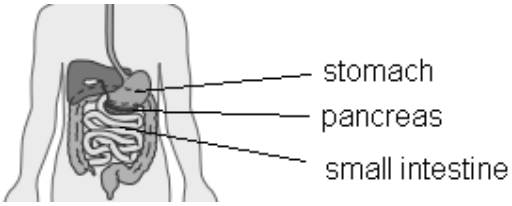
Question	Correct answer	Marks
1 a)	i) The response to light that is brighter in one direction than others is a growth response.	1 mark 1 mark
1 b)	Positive phototropism means growing towards light.	1 mark
1 c)	If shoots grow towards the light, there is a better chance of the plant receiving more light on its leaves, so are able to carry out photosynthesis faster and produce more food.	1 mark 1 mark
1 d)	Positive geotropism means growing in the direction of the force of gravity, that is, down into the Earth.	1 mark
1 e)	Roots that grow down into the soil are more likely to find soil water (and dissolved mineral ions), and so be able to supply the substances that the plant needs for healthy and rapid growth.	1 mark 1 mark
2 a)	They allow the body to respond to changes in the environment.	1 mark

<table>
<tr><td>2 b)</td><td><table>
<tr><th>System</th><th>Cells of system</th><th>Method of transmission</th><th>Speed of response</th></tr>
<tr><td>nervous</td><td>neurones, receptor cells, effector cells</td><td>electrical impulses through neurones</td><td>rapid</td></tr>
<tr><td>hormonal</td><td>glands, target cells</td><td>chemical hormones</td><td>slower, longer-lasting</td></tr>
</table></td><td>6 marks</td></tr>
<tr><td>2 c)</td><td>The nervous system enables the body to respond quickly but for a short time, such as using muscles to move.
The hormonal system enables the body to respond more slowly over a longer time, such as controlling blood glucose concentration,
and also can affect areas in different parts of the body at the same time, as with adrenaline affecting the heart, lungs and eyes.
These different responses enable the body to respond effectively to different stimuli,
and so increase the chances of survival.</td><td>1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>3 a)</td><td>Answers may vary, but should include the following:
• eyes sense the direction and speed of the ball
• electrical impulses via nerve cells from the eye to the central nervous system including the brain
• brain identifies best place to stand and how to move the racquet in order to hit the ball
• electrical impulses to muscles in the arm move the racquet into position and then to hit the ball</td><td>
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>3 b)</td><td>No, this isn't a reflex action
because the brain is involved, using memories of training in order to give the best response.</td><td>1 mark
1 mark</td></tr>
<tr><td>4 a)</td><td>There is no light in the mine, so there is no stimulus
for the light-sensitive receptor cells in the retina.</td><td>1 mark
1 mark</td></tr>
<tr><td>4 b)</td><td>Only some of the light entering the eye is able to get through the lens and reach the light-sensitive cells in the retina,
so the image produced will not be very clear.</td><td>1 mark
1 mark</td></tr>
<tr><td>4 c)</td><td>A long-sighted person cannot focus the light from something nearby clearly on the retina,
and needs additional converging lenses in the spectacles to produce a proper focusing for a clear image.</td><td>1 mark
1 mark</td></tr>
<tr><td>5 a)</td><td>Receptor, heat sensors in the skin and receptor cells in the hypothalamus that detect temperature of the blood flowing through them
Monitoring area, hypothalamus in the brain
Effectors, sweat glands if too hot; skin capillary walls to produce vasoconstriction or vasodilation; muscle cells if too cold to cause shivering</td><td>2 marks
1 mark
3 marks</td></tr>
</table>

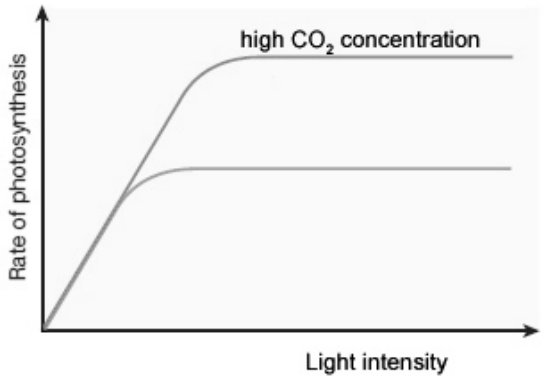
5 b)	Heat energy at the surface of the skin is transferred to the cooler environment by conduction and radiation. Blood flow nearer to the surface of the skin allows heat energy from the blood to be transferred to the skin surface faster than if the blood flow is reduced.	1 mark 1 mark
5 c)	The core of the body contains the lungs, heart and liver, where many essential reactions take place. Temperature affects the rate of reactions by affecting the rate of movement of molecules. Also, if temperature rises too far, enzymes that control reactions can denature. Slower reactions, due to a core temperature that is either too high or too low, can reduce the ability of the cells to carry out the life processes as quickly as needed for survival.	1 mark 1 mark 1 mark 1 mark
	Total:	44 marks

Section 2 Exam-style questions mark scheme

<table>
<tr><th>Question</th><th>Correct answer</th><th>Marks</th></tr>
<tr><td>2 a)</td><td>cell membrane
cytoplasm
nucleus
chromosomes
cell wall
cellulose
vacuole
chloroplasts
chlorophyll
photosynthesis</td><td>1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>2 b)</td><td>Ticks in table as shown below. 1 mark for each one correct.
<table>
<tr><th>Structure</th><th>Cell</th><th>Tissue</th><th>Organ</th></tr>
<tr><td>Blood</td><td></td><td>✓</td><td></td></tr>
<tr><td>Brain</td><td></td><td></td><td>✓</td></tr>
<tr><td>Liver</td><td></td><td></td><td>✓</td></tr>
<tr><td>Muscle</td><td></td><td>✓</td><td></td></tr>
<tr><td>Neurone</td><td>✓</td><td></td><td></td></tr>
<tr><td>Ovum</td><td>✓</td><td></td><td></td></tr>
<tr><td>Skin</td><td></td><td></td><td>✓</td></tr>
<tr><td>Sperm</td><td>✓</td><td></td><td></td></tr>
</table></td><td>8 marks</td></tr>
</table>

<table>
<tr><td>3 a)</td><td>Completed table as shown. 1 mark for each entry.
<table><tr><th>Biological molecule</th><th>Units that make up the molecule</th></tr><tr><td>Glycogen</td><td>glucose</td></tr><tr><td>Lipids</td><td>fatty acids
glycerol</td></tr><tr><td>Proteins</td><td>amino acids</td></tr><tr><td>Starch</td><td>glucose</td></tr></table></td><td>5 marks</td></tr>
<tr><td>3 b)</td><td>i) Add Benedict’s solution
to the sample to be tested (in a test tube).
Heat to 95 °C.
A colour change from blue to green to yellow to orange to red-brown/blue to red-brown
indicates that glucose/a reducing sugar is present in the sample.
ii) Add iodine solution
to a food sample (on a spotting tile).
A blue-black colour
indicates that starch is present in the sample.</td><td>1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>3 c)</td><td>i) stomach protease: 1.6
small intestine protease 8.0
ii) Enzyme activity depends on the substrate (in this instance, a protein) being able to fit into the shape of the enzyme (the active site of the enzyme).
Each enzyme has an optimum pH.
At pHs other than the optimum, the structure of the enzyme/active site changes,
so the substrate is unable to fit as well.
At a certain point, the structure of the enzyme is changed permanently (it is denatured) and is no longer able to work.</td><td>1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>3 d)</td><td> 
</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td>4 a)</td><td>+32.2
+21.8
–2.2
–13.5
–19.9
–20.4</td><td>1 mark
1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
</table>

4 b)	i) Axes drawn	1 mark
	Axes labelled, with units	1 mark
	Points plotted correctly	1 mark
	Points joined appropriately	1 mark
	ii) Student answer from graph:	
	accurate reading of intersection with *x*-axis	1 mark
	correct units [M]	1 mark
	iii) The cell membranes in the cells of the potato cylinders act as partially permeable membranes.	1 mark
	In low concentrations of sucrose and distilled water, water moves from where it is in high concentration in the solutions, to where it is in lower concentrations in the potato cells	1 mark
	by osmosis,	1 mark
	so the cylinders increase in mass.	1 mark
	In high concentrations of sucrose, water is in higher concentration in the potato cells so water moves out of the potato cells by osmosis,	1 mark
	so the potato cylinders decrease in mass.	1 mark
	When the concentrations of water inside the cells and out are equal/in equilibrium, there is no net movement of water	1 mark
4 c)	Under normal conditions when the plant is well-watered, the cells are full of water, which enters by osmosis.	1 mark
	The cells are turgid/swollen,	1 mark
	and this firmness provides the main support in non-woody/herbaceous plants.	1 mark
5 a)	A: branch of renal artery	1 mark
	B: glomerulus	1 mark
	C: Bowman's capsule	1 mark
	D: proximal convoluted tubule	1 mark
	E: nephron	1 mark
	F: collecting duct	1 mark
	G: distal convoluted tubule	1 mark
	H: branch of renal vein	1 mark
5 b)	Amino acids, glucose and salts are forced through the walls of the glomerulus and Bowman's capsule by ultrafiltration.	1 mark
	The proteins remain in the blood as their molecules are too large to be filtered through into the Bowman's capsule.	1 mark
	Amino acids and glucose are selectively reabsorbed along the convoluted tubule.	1 mark
	Salt may be excreted in the urine (or it can be reabsorbed into the blood), depending on levels in the body.	1 mark
5 c)	ADH helps the body to conserve water.	1 mark
	If the concentration of water in the blood is too low, ADH (antidiuretic	1 mark

	hormone) is released into the blood.	
	ADH makes the walls of the collecting ducts more permeable to water molecules, so more water moves from the collecting ducts to be returned to the blood.	1 mark
	The urine is more concentrated.	1 mark
	If there is surplus water in the body, the high concentration of water in the blood results in a reduction of ADH production.	1 mark
	The walls of the collecting duct become less permeable to water, and less water is reabsorbed into the blood.	1 mark
	The body produces a larger volume of dilute urine.	1 mark
6 a)	i) As the light intensity increases, the rate of photosynthesis increases,	1 mark
	as light energy is required to drive the process of photosynthesis.	1 mark
	At a certain point, the graph levels off, so any further increase in light intensity will result in no further increase in photosynthesis.	1 mark
	At this point, some other factor must be limiting, for example carbon dioxide, and preventing any further increase.	1 mark
	ii) Graph drawn with line as shown:	1 mark
		
	As carbon dioxide was a factor that was limiting the rate of photosynthesis where the graph levels off, in a higher concentration of carbon dioxide, the graph will continue to a higher point (i.e. a higher rate of photosynthesis) until it again levels off.	1 mark
	At this point, with light and carbon dioxide being available, other factor (e.g. temperature) must be preventing any further increase in the rate of photosynthesis.	1 mark
6 b)	i) Growth in response to the direction of light is called **phototropism**. If the growth is towards light, it is called **positive phototropism**, as shown by plant **shoots**.	1 mark 1 mark 1 mark
	Growth in response to gravity is called **geotropism**. Plant roots are **negatively geotropic**. This response helps the plant **roots** to grow **downwards** so the plant can obtain the **water** it needs.	1 mark 2 marks 2 marks
	ii) There is no significant difference between the amount of auxin in the plants kept in the dark or light, or total auxin in plants illuminated on one side,	1 mark
	so light has no effect on the production of auxin.	1 mark
	In the plant illuminated from one side, about 71% of the auxin in the plant is on the dark side,	1 mark

<table>
<tr><td></td><td>so as the total auxin was unaffected by light, the auxin must have been redistributed from the light to dark side.</td><td>1 mark</td></tr>
<tr><td>7 a)</td><td>i) A: cuticle
B: epidermis
C: palisade layer
D: spongy mesophyll
E: stoma
ii) Leaves have a large surface area for gas exchange.
Leaves are thin (usually less than 1 mm) so gases are only required to diffuse over small distances.
Stomata regulate the diffusion of gases in and out.
Cells have a moist surface required for the absorption and release of gases.
There are large air spaces between the cells of the spongy mesophyll so that gases can move freely.</td><td>1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>7 b)</td><td>Completed table as shown.
<table>
<tr><th></th><th>Phloem</th><th>Xylem</th></tr>
<tr><td>Substances transported</td><td>Sucrose – 1 mark
Amino acids – 1 mark
Allow 1 mark for ‘products of photosynthesis’</td><td>Water – 1 mark
Mineral salts – 1 mark</td></tr>
<tr><td>Substances are transported: from</td><td>Leaves – 1 mark
Allow ‘sites where photosynthesis is carried out’</td><td>Roots – 1 mark</td></tr>
<tr><td>Substances are transported: to</td><td>Parts of the plant where they are required – 1 mark</td><td>Throughout plant – 1 mark</td></tr>
</table></td><td>8 marks</td></tr>
<tr><td>8 a)</td><td>i) Flow chart as shown
stimulus (hot object) → rece tors in skin on finger → sensory neurone → relay neurone in spinal cord → motor neurone → effector (muscle) – moves hand</td><td>1 mark for each part, 6 marks total</td></tr>
<tr><td>8 a)</td><td>ii) Neurones in the spinal cord connect with longitudinal neurones
as synapses,
which run up the spinal cord to the brain (so that she knows that she has touched the object).</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td>8 b)</td><td>Hormonal/endocrine system
The response is electrical in the nervous system, and chemical in the hormonal system.
The response is carried by nerves/neurones in the nervous system, and in the blood in the hormonal system.</td><td>1 mark
1 mark
1 mark</td></tr>
</table>

	The response is very quick in the nervous system, and slower in the hormonal system.	1 mark
9 a)	i) A: right atrium	1 mark
	B: right ventricle	1 mark
	C: left atrium	1 mark
	D: left ventricle	1 mark
	ii) The walls of the chambers of the heart are muscular.	1 mark
	Contraction of the left atrium pumps blood to the lungs (the pulmonary circulation).	1 mark
	Contraction of the left atrium pumps blood to the whole of the body (the systemic circulation).	1 mark
	So blood in the systemic circulation has to be under higher pressure.	1 mark
9 b)	**Red blood cells**: These are packed with haemoglobin to transport oxygen	1 mark 1 mark
	from the lungs to the body's cells.	0 marks
	White blood cells: These are for defence.	1 mark
	Phagocytes ingest pathogens/microorganisms/other foreign bodies.	1 mark
	Lymphocytes produce antibodies that assist phagocytes in the ingestion of microorganisms/immune response.	1 mark
	Platelets: These are involved in clotting of blood,	1 mark
	which prevents blood loss and the entry of microorganisms.	1 mark
	Plasma: Involved in the transport of food, hormones, carbon dioxide, urea.	1 mark
	Involved in the distribution of heat.	
9 c)	The vaccine contains dead or weakened organisms that cause the disease.	1 mark
	Microorganisms in the vaccine match with antibodies on the surface of lymphocytes specific to that microorganism.	1 mark
	Lymphocytes divide and produce the specific antibodies in large numbers.	1 mark
	Antibodies attach to the microorganisms, and the microorganisms are phagocytosed by phagocytes.	1 mark
	Memory cells remain in the blood so that the person can respond quickly/produce antibodies quickly if exposed to the same microorganism.	1 mark

Section 3 Reproduction and inheritance

B3a Reproduction

Page 190

1.

	Sexual reproduction	Asexual reproduction
Similarities	• produce new individuals	
Differences	• fusion of male gamete with female gamete • offspring genetically different from parents and from each other • two parents • slower because male and female need to find each other and mate	• new individuals produced from division of body cell of parent • offspring genetically identical to parent • only one parent • faster because no search for mate

2. Any suitable example that refers to changing environment where genetic variability in offspring increases chance of survival of offspring that are genetically different to parent.

3. Answer should include: summer not long so asexual reproduction increases numbers more rapidly; summer short period, so variability of environment not as big a problem, so genetic variability would not be an advantage; if parent is feeding well on food plant, the offspring from that parent are equally likely to survive and grow well on that food plant, so variability would be a disadvantage.

Page 193

1. Produces the pollen

2. In pollen grains

3. Stigma where pollen grains attach; style which supports the stigma; ovary which surrounds and protects the ovule, inside which is the female gamete

Page 195

1. Wind-pollinated flowers: usually small; no colour (white); make masses of lightweight pollen

2. The lightweight pollen can be carried far in wind; stamens hang outside the flower so the pollen is more likely to be caught by wind.

3. Insect-pollinated flowers: usually large; may be brightly coloured; produce nectar and sometimes scent; make small amounts of larger pollen grains

4. Scent, nectar (as food), and large petals with bright colours all help to attract insects to the flower. As the insect feeds, they pick up pollen, which is then carried to other flowers.

Page 197

1. Pollination is the transfer of pollen from one flower to another. Fertilisation is the fusion of a male gamete with a female gamete to form a zygote.

2. Pollination (pollen grain lands on stigma); pollen tube grows down through style to ovule; pollen tube delivers male gamete to egg cell; nucleus of male gamete and nucleus of female gamete fuse to form zygote

3. Female gamete develops into embryo plant; ovule wall forms hard outer shell of seed; ovary forms fruit

Developing investigative skills, page 198

1. a) Set up two identical dishes with same number of seed, treated in exactly the same way for moisture and kept at same temperature, but one placed in bright light and one placed in dark cupboard.

   b) Set up two identical dishes with the same number of seed, placed in bright light, but one has a dry paper towel and other has a paper towel that is kept damp.

   c) Set up two identical dishes with the same number of seed, placed in bright light, treated in exactly the same way for moisture, but one kept cooler than the other (by any reasonable means).

2. Line graph with day on *x* axis and total number on *x* axis and total number on *y* axis, with two lines, one for each temperature clearly labelled.

3. a) Seeds that didn't germinate may have failed for many reasons, e.g. dead embryo, so should be ignored in the results. The conclusion should refer to more seeds germinating more quickly at the higher temperature.

   b) Increased temperature increases the rate of reaction increases the rate of action of enzymes that control reactions. So at the warmer temperature, reactions were carried out faster so that the cells grew faster.

Page 200 (top)

1. The food reserves provide the food molecules needed for respiration, so that cell growth can take place, until photosynthesis supplies food.

2. a) Essential for germination

   b) Increased temperature (up to the point when enzymes are denatured) increases rate of enzyme action and so growth

3. Most seeds germinate below the surface of the ground, where there is no light. If they needed light, they would not germinate.

4. Take a piece of old plant (such as piece of stem, root or shoot) → dip it into rooting hormone mixture → place it in compost → keep moist → after a few weeks roots will develop

Page 200 (bottom)

1. Sketch as Fig. 3.18 on page 200.

2. and 3. Labels and annotations as follows:

- testes: where sperm (male gametes) produced
- sperm duct: carry sperm to urethra
- prostate gland and seminal vesicles: produce liquid in which sperm swim
- penis: when erect delivers sperm into vagina of female
- urethra: tube that carries sperm from sperm ducts to outside the body

Page 201

1. Sketch as Fig. 3.19 on page 201.

2. and 3. Labels and annotations as follows:

- ovaries: where egg cells form
- oviducts: carry the eggs to the uterus and where fertilisation by sperm takes place
- uterus: where embryo implants into lining and fetus develops

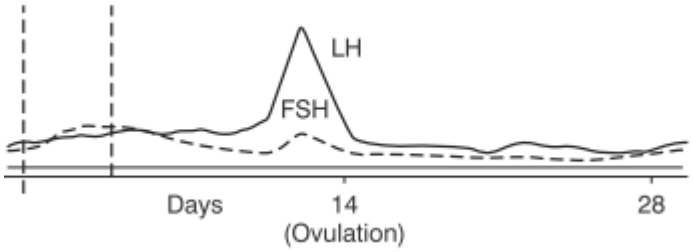
- cervix: base of uterus where sperm are deposited during sexual intercourse
- vagina: where penis is inserted during sexual intercourse

Page 203 (top)

1. a) and b) FSH: secreted from pituitary gland, target cell egg in ovary; oestrogen: secreted from developing egg in ovary, target cells include cells lining uterus wall and cells in pituitary gland; LH: secreted by pituitary gland, target cells in ovary, causing ovulation; progesterone: secreted by ovary cells, target cells include cells lining uterus wall and cells in pituitary gland (inhibiting FSH and LH secretion)

2. In the blood

3. a) and b) Sketch should include curves for oestrogen and progesterone as shown in Fig. 3.20 on page 202, plus curves similar in shape to the one below for FSH and LH (accuracy in height of curves not required). Annotations should indicate:
   - rise in FSH at start due to low levels of progesterone and oestrogen, fall when increasing progesterone inhibits production
   - rise in oestrogen as a result of developing egg, fall in oestrogen after egg ovulated
   - rise in LH due to high oestrogen, fall after progesterone increases and inhibits production rise in progesterone after ovulation, fall at end of cycle if egg not fertilised.



4. The actions happen over a long time, and target cells may be in more than one part of the body. Hormones can control these kinds of responses much more easily than the nervous system.

5. Although each hormone has a different effect, the coordination of all four hormones acts to keep the cycle within limits and produces a repeating pattern.

Page 203 (bottom)

1. Characteristics of the body that develop at puberty and prepare the body for sexual reproduction

2. The shedding of the thickened lining of the uterus and the start of the development of another egg in the ovary

3. Circle numbered 1 to 28 around the circle:

   a) ovulation at about day 14

   b) increase in oestrogen days 8–12, decrease days 12–14, increase again day 15, decrease again around day 18

   c) increase in progesterone days 14–c.18, decrease in progesterone c. days 23–28.

Page 206

1. a) Zygote: cell produced by fusion of a male gamete and female gamete

   b) Embryo: dividing ball of cells formed from the zygote, which implants in the uterus wall lining

   c) Fetus: developing baby in the uterus (womb) from the time when the placenta has developed.

2. a) Protects the baby from bumps from the outside world and from wide variation in temperature

   b) Provides nutrients from mother's blood and carries waste to mother's blood to be excreted

3. For the exchange of materials. Substances such as glucose (food molecules), oxygen and other nutrients diffuse from the mother's blood into the fetus's blood, and waste products such as carbon dioxide and urea diffuse from the fetus's blood into the mother's blood. The rate of diffusion is faster over a large surface area and when the distance that needs to be crossed is as short as possible.
The placenta provides both of these so that diffusion is as rapid as possible.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	For reproduction	1 mark
1 b)	Anthers	1 mark
1 c)	They contain the male gametes in the pollen grains.	1 mark
1 d)	Wind	1 mark
	because there are no bright petals or colour to attract insects,	1 mark
	and the anthers are held outside the flower so that they catch the wind easily.	1 mark
2 a)	Germination is when the seed begins to swell and break open the seed coat so that the embryo plant can grow.	1 mark
2 b)	Moisture is needed so that the enzymes in the seed can start to work.	1 mark
	Warmth is needed so the enzyme action is as fast as possible.	1 mark
2 c)	Small seeds contain fewer food reserves than large seeds,	1 mark
	so seedlings from small seeds need to start photosynthesising more quickly than those from larger seeds.	1 mark
	If small seeds are planted too deeply, they may run out of energy supplied from their food reserves if they cannot get their leaves to the surface in time.	1 mark
2 d)	If they germinated too late in the year, they would not be able to grow enough before winter	1 mark
	to flower and reproduce before the winter killed them.	1 mark
3 a)	Make less pollen, less waste of pollen as insects more likely to deliver pollen to the flower than random distribution in wind	1 mark
3 b)	If the insect species die out, the plant will not get pollinated.	1 mark
4 a)	The sperm cell is made in the testes.	1 mark
4 b)	The egg cells are formed in the ovaries.	1 mark
4 c)	Fertilisation takes place inside one of the oviducts.	1 mark
4 d)	The sperm travels down the sperm duct and mixes with liquids from the prostate gland and seminal vesicles to form semen.	1 mark
	Semen is ejaculated during sexual intercourse and deposited close to the cervix at the top of the vagina.	1 mark
	The egg cell is released from the ovary and travels along the oviduct.	1 mark
	If sperm reach the egg cell in the oviduct, the egg cell may be fertilised.	1 mark
5	Oestrogen is secreted by cells around the egg cell.	1 mark
	Just before ovulation, the amount of oestrogen that is secreted drops.	1 mark
	Cells in the ovary then start secreting progesterone, and a little more	1 mark

	oestrogen is secreted – these cause an increase in thickness of the uterus lining. At about 28 days, the amounts of oestrogen and progesterone start to fall, causing the uterus lining to break down and a new egg cell to start developing in the ovary.	 1 mark
6 a)	An organ produced by the fetus that attaches to the lining of the uterus	1 mark
6 b)	Substances such as oxygen, carbon dioxide and glucose are exchanged between the mother and the developing fetus.	1 mark
6 c)	Diffusion of small molecules Osmosis of water	1 mark 1 mark
6 d)	It prevents pathogens and large molecules (such as some chemicals) crossing from the mother's blood into the fetus.	1 mark
6 e)	The fetus needs oxygen for respiration, so that its cells may grow well. It gets that oxygen from its mother's blood via the placenta. If the mother's blood isn't carrying as much oxygen, then the fetus will get less oxygen and respiration will be carried out more slowly. This will result in slower growth of the cells in the fetus, so it will be lighter in weight than normal at birth.	1 mark 1 mark 1 mark 1 mark
	Total:	35 marks

B3b Inheritance

Page 214

1. Gene, chromosome, nucleus, cell

2. a) The shape of the DNA molecule, a twisted ladder shape with two strands joined by pairs of bases

   b) The 'rungs' of the DNA double helix, which are formed from an AT pair or a GC pair

3. Different forms of the same gene that code for different variations of the same characteristic, such as different eye colours

Page 216

1. a) The characteristic is fully expressed in the phenotype even when the organism has only one allele of that form for that gene (heterozygous).

   b) The characteristic is only expressed in the phenotype when both alleles for that gene are of this form and is not expressed in a heterozygote.

   c) Having two identical copies of that allele for a particular gene.

   d) Having different alleles for a particular gene.

2. a) 2

   b) 1

   c) 2

Page 219

1. The inheritance of a characteristic produced by one gene

2. Genotype (the alleles in the chromosomes) BB, phenotype (what the organism looks like) brown; genotype Bb, phenotype brown (because the brown allele is dominant); genotype bb, phenotype black (because the organism doesn't have the brown allele)

3. a) Answer may be presented as a full layout diagram or a Punnett square, showing the adult genotypes and phenotypes (male Bb brown and female Bb black), the possible gametes produced (male B and b, female B and b), genotypes and phenotypes of possible offspring (BB brown, Bb brown, Bb brown, bb black).

b) This cross produces a theoretical probability of one black rabbit for every three brown rabbits, a ratio of 1:3, probability of 1 in 4 or 25%.

Developing investigative skills, page 220

1. Start with two beakers, containing the same number of beads, but half the beads in each beaker are red and half are blue, because half the gametes will receive the dominant allele during meiosis and the other half will receive the recessive allele. Start with many beads in each pot, well mixed.

For each 'fertilisation' take one bead (gamete) from one beaker, without looking because fertilisation is random. Then take one bead, without looking, from the other beaker. Place the two beads together to represent the genotype of the offspring.

2. There would be 20 red beads and 20 blue beads in each pot because, as a result of meiosis, half the gametes will receive one allele from the diploid parent cell and half the gametes will receive the other allele.

3. Genetic diagram or Punnett square, using letters of own choice linked to red and blue beads, such as the following.

R is dominant allele, represented by red bead; r is recessive allele, represented by blue bead.

		gametes	
		R	r
gametes	R	RR	Rr
	r	Rr	rr

Predicted probabilities are 1 RR : 2 Rr : 1 rr for genotypes and 3 dominant : 1 recessive for phenotypes.

4. Actual results are 1 red/red : 2.4 red/blue : 0.6 blue/blue for genotypes and 5.7 dominant : 1 recessive for phenotypes.

5. The actual results vary quite a bit from the predicted results because only a small number of repeats was carried out.

6. If the number of repeats was increased, it is likely that the actual results will get closer to the predicted ones.

Page 223 (top)

1. So that, when the plants were bred together, the results in the offspring were not confused by a mix of alleles in one or both of the parents

2. Random variation is possible in the results. So the larger the sample, the more likely that any random variation will be averaged out.

3. He removed the stamens from every flower, so that pollen could not be transferred by insect. He also covered each flower after he had hand-pollinated it, so that other pollen could not get to the stigma.

4. Any characteristic may be used, with alleles appropriately designated with capital letter for dominant and lower-case letter for recessive allele. Parents used should show one with phenotype of dominant allele, homozygous, such as BB, and one parent with phenotype of recessive allele, that is bb. First cross will produce all individuals with phenotype of dominant allele but heterozygous in genotype, that is

Bb. Crossing of these individuals will produce characteristic 1 BB : 2 Bb : 1 bb in genotype and 3 dominant characteristic to 1 recessive characteristic in next generation.

5. If Mendel had not been as thorough about his method, then his results would not have been as clear and predictable. So he would not have been able to have drawn clear and repeatable conclusions about the way characteristics are inherited in pea plants.

Page 223 (bottom)

1. When both alleles are expressed in the phenotype, and there is no dominance of one allele over the other

2. a) IA and IB

b) Only Io

c)

			Father AB	
			Gametes	
			IA	IB
Mother O	Gametes	Io	IAIo blood group A	IBIo blood group B
		Io	IAIo blood group A	IBIo blood group B

d) There is a 1 : 1 ratio, 50% probability or a 1 in 2 chance of blood group A and blood group B.

Page 225

1. 3

2. 2

3. 2

4. ‘Freckles’ appears to be dominant because this variation of the characteristic is inherited in every generation, even though the other parent is unfreckled.

Page 226

1. XX

2. XY

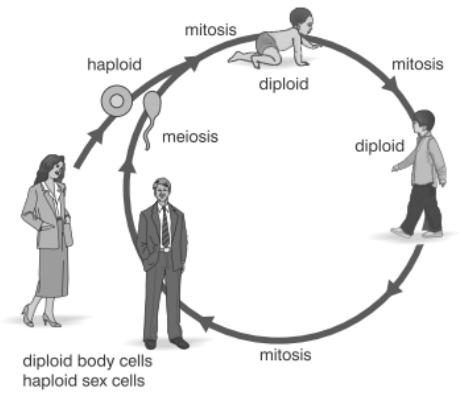
3. 50% (or 1 in 2), because there is an equal chance that an X sperm or a Y sperm will fertilise the X egg cell

Page 229

1.

2. Diploid body cell → chromosomes duplicate → chromosomes line up across middle of cell → copies of chromosomes separate and each copy goes to the opposite side of the cell → cell divides in two to produce two identical diploid body cells

3. Diploid body cell → chromosomes duplicate → chromosome pairs line up across middle of cell → one chromosome from each pair moves to opposite sides of the cell → cell divides in two → chromosomes line up across middle of cells → chromosome copies separate and each copy goes to the opposite side of the cells → cells divide in two to form four



haploid cells that are not genetically identical

4. Meiosis produces non-identical cells, so there is variety in the gamete cells. When the gamete cells fuse, this will mean that the offspring will vary from each other.

Page 231

1. a) Genes, such as eye colour; environment, such as weight as a result of diet. (Other suitable examples are acceptable.)

   b) Any suitable example showing a combination of genes and environment, such as human height, which depends on genes and a healthy diet to achieve the potential of the genes.

2. A change in a gene so that it produces a different form of a characteristic

3. Ionising radiation, such as ultraviolet radiation, X rays or gamma rays; chemical mutagens such as the chemicals in tobacco smoke

Page 235

1. a) Evolution: change in the characteristics of a species over time

   b) Natural selection: the influence of the environment on survival and/or reproduction, such that organisms with some characteristics are more successful at producing offspring than others

2. a) If the individuals in a population are all the same, natural selection will favour (or disadvantage) them all equally.

   b) If individuals with a particular variation of a characteristic have a greater survival advantage, they are more likely to produce offspring that carry their genes, and so their genes will become more common in the next generation.

3. Diagrams should show the following:
person infected with bacteria → bacteria grow in number inside patient → treatment of patient with antibiotics kills off least resistant bacteria but most-resistant bacteria survive → some of these bacteria escape into the environment from the patient and infect another person → the same antibiotic cannot be used on that patient as the bacteria are resistant

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	The nucleus in a cell contains the chromosomes, which are made from DNA. A gene is a short piece of that DNA.	1 mark 1 mark

<table>
<tr><td>2 a)</td><td>Using any suitable symbols for wet and dry ear wax, such as E for wet and e for dry, either a layout or a Punnett square including the following information:

<table>
<tr><td colspan="2"></td><td colspan="2">father's gametes</td></tr>
<tr><td colspan="2"></td><td>e</td><td>e</td></tr>
<tr><td rowspan="2">mother's gametes</td><td>E</td><td>Ee
wet earwax</td><td>Ee
wet earwax</td></tr>
<tr><td>e</td><td>ee
dry earwax</td><td>ee
dry earwax</td></tr>
</table>

suitable use of letters for alleles
definition of letter for each allele
correct gametes for parents
correct genotypes for offspring
correct phenotypes for offspring</td><td>

1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>2 b)</td><td>Predicted genotypes 1 : 1 Ee to ee, 50% or 1 in 2 chance of either outcome
Predicted phenotypes: 1 : 1 wet to dry, 50% or 1 in 2 chance of either outcome</td><td>1 mark
1 mark</td></tr>
<tr><td>2 c)</td><td>The chance of inheriting wet or dry earwax is the same at each fertilisation. So it is a 50% chance each time.
Random fertilisation means it could give the same result each time.</td><td>1 mark
1 mark</td></tr>
<tr><td>3</td><td>The cross will produce plants that are heterozygous, with one red and one white allele.
If either allele was dominant, then all the offspring would have flowers of the colour that the allele produces.
Instead the flowers show splashes of each colour, suggesting that both alleles are being expressed equally.</td><td>1 mark
1 mark
1 mark</td></tr>
<tr><td>4 a)</td><td>A random change in an allele</td><td>1 mark</td></tr>
<tr><td>4 b)</td><td>Ionising radiation
mutagenic chemicals</td><td>1 mark
1 mark</td></tr>
<tr><td>4 c)</td><td>Ionising radiation from UV light as a result of overexposure of skin to sunlight.
Because skin is more exposed to this form of radiation than other parts of the body.</td><td>1 mark
1 mark</td></tr>
<tr><td>4 d)</td><td>i) Both curves increased
from about 500 new cases to over 200 new cases for men and around 1500 new cases for women.
ii) Any suitable explanation that refers to increased exposure to stronger sunlight such as: more holidays in tropical regions, people trying to get darker tans.
This increases the risk of overexposure to UV light.</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
</table>

5	If there were no meiosis, the chromosome number of the zygote would double each time there was fertilisation. Meiosis halves the number of chromosomes, and then the full number is restored during fertilisation.	1 mark 1 mark
6	Asexual reproduction occurs as a result of mitosis of diploid cells. This form of cell division produces identical diploid cells, so asexual reproduction produces offspring that are genetically identical to the parent. Sexual reproduction involves gametes that have been produced by meiosis. This form of cell division produces haploid cells that are not identical. Random fertilisation means that the zygotes produced will vary in their genes, so the offspring will show variation in their characteristics.	1 mark 1 mark 1 mark 1 mark
7	Humans produce few offspring so, as a result of random fertilisation, the variation in offspring may not match the predicted variation from a genetic diagram. This makes it difficult to identify a dominant or recessive allele through proportion of alleles in the offspring. A family pedigree shows inheritance over several generations and a wider number of individuals, which makes it easier to see how a particular allele has been passed down. This makes it easier to tell whether the allele is dominant or recessive.	1 mark 1 mark 1 mark 1 mark
8	Treatment of person 1 with antibiotic A kills off the less-resistant bacteria, but more-resistant bacteria survive → the more-resistant bacteria escape to the environment and infect person 2 → person 2 falls ill, antibiotic A won't control the infection so person 2 is given a different antibiotic (antibiotic B) → the less-resistant bacteria are killed by antibiotic B but the more-resistant bacteria survive → these bacteria escape to the environment and infect person 3 → person 3 falls ill and antibiotics A and B will not have an effect, so they are treated with antibiotic C … and so on.	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
	Total:	39 marks

Section 3: Exam-style questions mark scheme

Question	Correct answer	Marks
2 a)	Hint: In questions of this type, tell students that they should always have a good look through the family tree, and see what genotypes you can identify, before they even look at the questions. i) Cc (0 marks for this alone – an explanation is required) Father A does not have cystic fibrosis, so must have at least one dominant allele. But as the son (C) has cystic fibrosis, the father must be Cc	 1 mark 1 mark

<table>
<tr><td></td><td>(and not CC – if he was CC, there would be no chance of producing a child with cystic fibrosis).
ii) Cc (0 marks for this alone – an explanation is required)
Daughter D is normal, but must have inherited one cystic fibrosis gene from her mother.
She must be Cc.
iii) Daughter G has cystic fibrosis, so must be cc
so must have inherited one cystic fibrosis allele from each parent.
As both parents E and F are normal, both must be Cc.</td><td>

1 mark
1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>2 b)</td><td>A
D
E
F
(they are all normal but have one recessive allele)</td><td>1 mark
1 mark
1 mark
1 mark</td></tr>
<tr><td>3 a)</td><td>i) (Codominance is) a condition where both alleles of a gene pair are both expressed.
Neither is dominant over the other.
ii) A red bull and a white cow:
<table><tr><td colspan="2"></td><td>Female – C^WC^W – 1 mark
possible alleles in eggs</td></tr><tr><td colspan="2"></td><td>C^W – 1 mark</td></tr><tr><td>Male – C^RC^R – 1 mark
possible alleles in sperm</td><td>C^R – 1 mark</td><td>C^RC^W – 1 mark
roan cattle – 1 mark</td></tr></table></td><td>1 mark
1 mark
6 marks</td></tr>
<tr><td>3 a)</td><td>ii) Ratio of offspring produced – all roan
A roan bull and a white cow:
<table><tr><td colspan="2"></td><td>Female – C^WC^W – 1 mark
possible alleles in eggs</td></tr><tr><td colspan="2"></td><td>C^W – 1 mark</td></tr><tr><td rowspan="2">Male – C^RC^W (1) – 1 mark
possible alleles in sperm</td><td>C^R – 1 mark</td><td>C^RC^W – 1 mark
roan cattle – 1 mark</td></tr><tr><td>C^W – 1 mark</td><td>C^WC^W – 1 mark
white – 1 mark</td></tr></table></td><td>1 mark</td></tr>
<tr><td>3 a)</td><td>ii) Ratio of offspring produced – 1 roan: 1 white</td><td>1 mark</td></tr>
</table>

<table>
<tr>
<td>3 b)</td>
<td>
The genotype of the father is either $I^A I^A$ or $I^A I^O$
The genotype of the mother is either $I^B I^B$ or $I^B I^O$
The possible combinations are:
If the father is $I^A I^A$ and the mother is $I^B I^B$
There is no chance of a child being blood group A or O
Explanation (note, not required in this instance):
<table>
<tr><td></td><td></td><td>Mother – $I^B I^B$
possible alleles in eggs</td></tr>
<tr><td></td><td></td><td>I^B</td></tr>
<tr><td>Father - $I^A I^A$
possible alleles in sperm</td><td>I^A</td><td>$I^A I^B$
Blood group AB</td></tr>
</table>
</td>
<td>1 mark
1 mark

1 mark</td>
</tr>
<tr>
<td>3 b)</td>
<td>
If the father is $I^A I^A$ and the mother is $I^B I^O$
There is a probability of 1 in 2 of the child being blood group A.
There is no chance of the child being blood group O.
Explanation (note, not required in this instance):
<table>
<tr><td></td><td></td><td colspan="2">Mother – $I^B I^O$
possible alleles in eggs</td></tr>
<tr><td></td><td></td><td>I^B</td><td>I^O</td></tr>
<tr><td>Father – $I^A I^A$
possible alleles in sperm</td><td>I^A</td><td>$I^A I^B$
Blood group AB</td><td>$I^A I^O$
Blood group A</td></tr>
</table>
</td>
<td>1 mark
1 mark</td>
</tr>
<tr>
<td>3 b)</td>
<td>
If the father is $I^A I^O$ and the mother is $I^B I^B$
There is no chance of a child being blood group A or O
Explanation (note, not required in this instance):
<table>
<tr><td></td><td></td><td colspan="2">Mother – $I^B I^O$
possible alleles in eggs</td></tr>
<tr><td></td><td></td><td>I^B</td><td>I^O</td></tr>
<tr><td>Father – $I^A I^A$
possible alleles in sperm</td><td>I^A</td><td>$I^A I^B$
Blood group AB</td><td>$I^A I^O$
Blood group A</td></tr>
</table>
</td>
<td>1 mark</td>
</tr>
</table>

	<table><tr><td></td><td></td><td>Mother – $I^B I^B$ possible alleles in eggs</td></tr><tr><td></td><td></td><td>I^B</td></tr><tr><td>Father – $I^A I^O$ possible alleles in sperm</td><td>I^A</td><td>$I^A I^B$ Blood group AB</td></tr><tr><td></td><td>I^O</td><td>$C^B C^O$ Blood group B</td></tr></table>	
3 b)	**If the father is $I^A I^O$ and the mother is $I^B I^O$** There is a 1 in 4 chance of a child being blood group A. There is a 1 in 4 chance of the child being blood group O. Explanation (note, not required in this instance): <table><tr><td></td><td></td><td>Mother – $I^B I^O$ possible alleles in eggs</td><td></td></tr><tr><td></td><td></td><td>I^B</td><td>I^O</td></tr><tr><td>Father – $I^A I^O$ possible alleles in sperm</td><td>I^A</td><td>$I^A I^B$ Blood group AB</td><td>$I^A I^O$ Blood group A</td></tr><tr><td></td><td>I^O</td><td>$I^B I^O$ Blood group B</td><td>$I^O I^O$ Blood group O</td></tr></table>	1 mark 1 mark
4 a)	gametes fertilisation two zygote	1 mark 1 mark 1 mark 1 mark
4 b)	i) Asexual reproduction: Advantage: only one parent required/large numbers can be produced quickly/because genetically identical, can survive well in conditions suited to them. Disadvantage: if the environment changes, or there is diseases, lack of variation means that they could all die out. ii) Sexual reproduction: Advantage: genetic information from both parents leads to variety in the offspring, leading to better chances of survival. Disadvantage: two parents required; in some habitats, for example, the desert, the human body, it may be difficult for two parents to meet/it takes longer to produce off spring.	 1 mark 1 mark 1 mark 1 mark

4 c)	i) A: uterus	1 mark
	B: cervix	1 mark
	C: vulva	1 mark
	D: vagina	1 mark
	E: ovary	1 mark
	F: Fallopian tube/oviduct	1 mark
	ii) Oestrogen stimulates the repair and thickening of the lining of the uterus.	1 mark
	Before ovulation, cells in the ovary start to secrete progesterone, which stimulates the uterus lining to thicken in readiness for a fertilised egg.	1 mark
	After ovulation, the corpus luteum continues to produce more progesterone.	1 mark
5 a)	A: stigma	1 mark
	B: style	1 mark
	C: ovary	1 mark
	D: carpel	1 mark
	E: anther	1 mark
	F: filament	1 mark
	G: stamen	1 mark
	H: petal	1 mark
	I: ovule	1 mark
	J: sepal	1 mark
5 b)	i): Petals – small as no need to attract insects	1 mark
	green or inconspicuous, as no need to attract insects	1 mark
	ii) Stigma – large and feathery/large surface area to collect pollen	1 mark
	hang down outside the flower to collect pollen	1 mark
	iii) Stamens – large to produce huge numbers of pollen	1 mark
	hang down outside the flower to release pollen into wind	1 mark
	iv) Pollen grains – large numbers produced (as chances of reaching another flower when carried by the wind are low (lower than if carried by an insect)	1 mark
	light, so as to be carried by the wind	1 mark

<table>
<tr><td>6 a)</td><td>Completed table as shown

<table>
<tr><th></th><th>Mitosis</th><th>Meiosis</th><th>Mitosis and meiosis</th><th>Neither mitosis or meiosis</th></tr>
<tr><td>The chromosome number in each daughter cell is 64.</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>The daughter cells are haploid.</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>Two identical cells are produced.</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>The nuclear membrane breaks disappears at the beginning, and is reformed at the end of the process.</td><td></td><td></td><td>✓</td><td></td></tr>
<tr><td>Some variability occurs in the alleles of parent and daughter chromosomes.</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>Occurs when new red blood cells are produced in the blood of the horse.</td><td></td><td></td><td></td><td>✓</td></tr>
</table>
</td><td>6 marks</td></tr>
<tr><td>6 b)</td><td>If the cells producing the gametes did not divide by meiosis, the gametes would have the same number of chromosomes as body cells

so at fertilisation

the chromosome number of the zygote would be double that of the parent

a reduction division/meiosis has to take place to produce gametes with half the number of chromosomes

so that on fertilisation, the normal number of chromosomes is restored.</td><td>1 mark

1 mark

1 mark

1 mark

1 mark</td></tr>
</table>

Section 4 Ecology and the environment

B4a The organism in the environment

Page 252

1. An ecosystem is all the organisms and the environmental factors that interact within an area. Examples include a lake, desert, tropical rainforest, coral reef, or anything similarly large-scale that has reasonably definable boundaries.

2. A habitat is the space in which a species/population of one species lives, such as under a rotting log, in the open water of a pond or lake, or anything of similar scale.

3. Populations of different species that live in different habitats form the community of organisms that live in an ecosystem.

Developing investigative skills, page 254

1. Plan should allow sampling for about one hour on each of the two sites. Each site needs marking with tape measures or some other method, in order to identify positions of quadrats. Students should use random sampling, e.g. with random numbers from a calculator, to place quadrats. Plants within each quadrat should be counted and identified (or characteristics of each species recorded for identification back in the lab). Physical factors measured should include light intensity using a light meter. Other factors that might have an effect on abundance should be considered, such as temperature, availability of water, presence of other organisms especially grazing animals.

2. Averages: species A south 12.4; species B south 7.0; species A north 5.8; species B north 12.0.

3. There were on average more species A plants on the south side of the hill than on the north side of the hill. Species B plant was, on average, more abundant on the north face of the hill than on the south face of the hill.

4. The abundance of the species varies with the light intensity measured. So light intensity may affect the abundance of these plants, with species A preferring a habitat where light intensity is high and species B preferring a habitat where light intensity is lower.

5. a) Moving randomly placed quadrats means that the sampling was not random. This might change the averages and so affect the results and therefore the conclusions that can be drawn.

   b) Taking samples from the top part of each slope might help to avoid the effect of a difference in water availability to the plants.

   c) Light intensity on the two slopes needs to be measured in identical conditions, e.g. at the same time, over the same period (to get an average intensity for the area).

Page 255

1. A square of a specific size, used for defining a sample area

2. The number of individuals within a given area

3. Choice might favour some parts of the area over others, such as places where there are no stinging or thorny plants. This may change the results, increasing or decreasing the average for some species, and therefore will change the conclusions that are drawn.

4. It is a quick method of identifying abundance for a very common species.

Page 256

1. How organisms are spread within an area

2. A sampling line along which quadrats are placed for taking samples

3. A line transect placed so that it runs from one habitat to another (from a pond edge to a field, or from shade to light under a large tree), can be sampled to show how the factor that is changing (i.e. water availability, or light intensity) affects the distribution of the organisms.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Any suitable answers that mean the same as the following: a) A large unit of the environment including all the organisms that live in it and the physical factors they interact with	 1 mark
1 b)	b) A small part of the environment in which a population of one species lives	1 mark
1 c)	c) All the organisms of one species that live in the same habitat	1 mark
1 d)	d) All the populations of organisms, of different species, that live in the same ecosystem	1 mark
2	Any suitable ecosystem could be used, with appropriate examples, such as for a lake: ecosystem: the lake habitat: in mid-water or in the mud at the bottom population: perch swimming in the midwater area of the lake community: all the organisms living in the lake.	 1 mark 1 mark 1 mark 1 mark
3	Use quadrats (e.g. 50×50 cm square), placed using random coordinates generated by a calculator, on a grid set out by two long measuring tapes on two sides of the field that meet at a corner. In each quadrat count the number of snails of the species being studied. Take at least 10 samples, more if time allows. Average the measurements from each quadrat, then multiply the result by 400 to give the population size for the field. Random sampling, as large a number of samples as possible and averaging the results will help to give as reliable a value as possible.	1 mark 1 mark 1 mark
4	The average number of dandelions in 1 quadrat (1 m^2) was 25 ÷ 10 = 2.5. The field is 200 m^2 so the total number of dandelions is 2.5 × 200 = 500.	1 mark 1 mark
5 a)	Five species – each line of the diagram is one species	1 mark
5 b)	i) Light intensity will not vary across the transect except when species growing within the creek are submerged by water at high tide. ii) Time submerged in sea water will vary within the creek but not beyond the creek where plants are not normally submerged. iii) Temperature may vary for species submerged by sea water for some part of the day, but for plants on dry land it will be the same.	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
5 c)	Green algae and samphire/*Salicornia* can grow in the creek, the rest grow on 'dry' land because the transect was measured from the middle of the creek.	1 mark
5 d)	i) Any suitable explanation, such as: need to be submerged in sea water	1 mark

	for part of the day to keep cooler/reduce light intensity; cannot compete with other species; only species that can tolerate submersion in sea water for large part of day. ii) Any suitable answer that tests the answer in part (i) by experimentation with details such as: place pots containing each species submerged in sea water and see how well each grows.	 1 mark 1 mark
	Total:	25 marks

B4b Feeding relationships

Page 262

1. Any description that means the same as:

   a) Organism that produces its own food from simpler materials, such as plants making carbohydrates in photosynthesis

   b) Animal that eats producers, also a herbivore

   c) Animal that eats primary consumers (grouped with other meat-eaters as a carnivore)

   d) Organism that causes decay of dead material, such as some fungi and bacteria

2. a) Primary consumers because they eat producers/plants

   b) Any consumer level above primary consumer because they eat other animals

   c) Any consumer level because they eat both plant and animal tissue

3. They feed on dead/decaying tissue and waste materials, but food chains only show the feeding relationships between living organisms.

Page 263

1. Insectivorous bird or toad

2. The fox feeds as a primary consumer on rabbits, rats, mice and seed-eating birds. It also feeds as a quaternary consumer on insectivorous birds.

Developing investigative skills, page 266

1. Plants > snails; plants are producers and snails are primary consumers.

2. Plan should include the following:

- method for sampling standard size areas, e.g. quadrat
- counting all individual plants and snails in each area
- repeat samples so that means can be calculated to average out variability.

3. Take several average sized plants. Dry out in warm oven overnight. Measure mass. Repeat drying for a few more hours and measure mass. Repeat until two consecutive masses are the same. Calculate an average mass per plant. Then do the same for several snails and average the mass for one snail.

4. Plants 42, snails 4.

5. Pyramid with two bars centred one on top of other, bottom bar 38 units wide and top bar 4 units wide.

6. Pyramid with two bars centred one on top of the other, bottom bar 1596 units wide and top bar 24 units wide.

7. Both pyramids show the typical shape of the top trophic level being smaller than the lower level. This is because the animals can only eat a proportion of the plants.

Page 268

1. a) A diagram showing the numbers of organisms at each trophic level in a food chain or food web in an area

   b) A diagram showing the biomass of organisms at each trophic level in a food chain or food web in an area

   c) A diagram showing the energy in the organisms at each trophic level in a food chain or food web in an area

2. Any suitable example that includes producers, primary consumers and secondary consumers from a reasonable food chain. Count the number of individuals feeding at each level within the same size area. Draw a pyramid of three layers, starting with producers at the bottom and ending with secondary consumers at the top, with the bar for each level drawn to scale.

3. A pyramid of biomass only shows the mass at a particular time in an area. If some trophic levels have a shorter lifespan than others, they will be under-represented in the pyramid, which may cause an inverted shape.

Page 270

1. Humans eat plant and animal tissue.

2. Wheat grain → human; wheat grain → chicken → human

3. For wheat grain → human, two steps with wheat at the bottom; for wheat grain → chicken → human, three steps with wheat grain at the bottom and human at the top

In both pyramids, the steps should get increasingly narrower from the bottom step up the pyramid.

4. As chickens transfer some energy to the environment as heat due to respiration, a smaller proportion of the energy in the wheat is available for humans to eat. This makes this energy transfer less efficient than humans eating the grain directly.

5. a) If we all become vegetarian, then more of the energy in the plants we grow is available to us than if we eat animals that eat the plants.

   b) Humans don't eat grass, so we would need to convert meadows (such as where sheep feed) to crop fields and not all the places where there are meadows will grow crops well. Also, fish are in a food chain that starts with microscopic plankton. Gathering sufficient photosynthetic plankton to eat could take more energy than harvesting the fish that eat them.

Page 271 (top)

1. Light energy from Sun (gain) → some reflected, some passes straight through, some wrong wavelength (losses) → light energy converted to chemical energy during photosynthesis → heat energy transferred to environment from photosynthetic reactions and from respiration (losses) → chemical energy in plant biomass

2. Chemical energy in food (gain) → chemical energy in undigested food lost as faeces (loss) → chemical energy in absorbed food molecules converted to chemical energy in waste products such as urea lost in urine (loss) → heat energy from respiration transferred to environment (loss) → chemical energy in animal biomass

3. Only a proportion of the energy taken in is used to make new biomass, the rest is lost to the environment either as chemical or heat energy. That means there is always less energy transferred to the next trophic level than was take in, so the shape must always be a pyramid.

Page 271 (bottom)

1. Any element found in plant or animal tissue, such as carbon or nitrogen

2. Both flow in one direction only, but energy is eventually lost to the environment in the form of heat energy whereas substances are retained or recycled back to the start of the chain.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Carnivore	1 mark
	because it eats animals	1 mark
1 b)	Primary consumer	1 mark
1 c)	organisms in correct order	1 mark
	arrows point in right direction	1 mark
	grass → zebra → lion	
1 d)	Food web showing grass at bottom	1 mark
	arrows to zebra, gazelle and wildebeest in middle layer	1 mark
	arrows from zebra, gazelle and wildebeest to lions in top layer	1 mark
2 a)	Pyramid of three bars drawn to scale	1 mark
	centred one above the other with producer at bottom and secondary consumer at top	1 mark
	and lowest bar five units wide labelled lettuce or producer, middle bar 40 units wide labelled caterpillar or primary consumer, top bar two units wide labelled thrush or secondary consumer.	1 mark
2 b)	There are two kinds of limitation: the pyramid has an inverted shape,	1 mark
	and the data are very limited, for example the thrushes feed on insects elsewhere, so the pyramid is not a reliable picture of the community.	1 mark
2 c)	A pyramid of biomass describes the data at one particular time. At one point there were 40 caterpillars and later there were none,	1 mark
	so sampling at different times would give different results.	1 mark
3 a)	The predatory insects would most likely decrease in number	1 mark
	because many would starve for lack of food.	1 mark
3 b)	The insectivorous birds would also decrease in number	1 mark
	because the species they eat all feed on predatory insects and so would decrease in number.	1 mark
3 c)	The mice may increase in number	1 mark
	because there might be more food if there are no herbivorous insects.	1 mark
3 d)	The snakes may not change in number	1 mark
	as they could replace the animals that would be decreasing in number due to the loss of herbivorous insects with mice and seed-eating birds that may be increasing in number.	1 mark
4 a)	Caterpillars	1 mark
	because they eat the leaves of the tree.	1 mark
4 b)	Because the tree has been counted as one organism, which means that it is much smaller than the caterpillar bar.	1 mark
4 c)	The caterpillar bar would be much smaller	1 mark
	because they would have become butterflies and flown away.	
4 d)	It would have a typical pyramid shape widest at the bottom.	1 mark

	This is because there is a lot of energy in all of the leaves of the tree so the bottom bar would be much wider.	1 mark
5 a)	Of the light energy captured by plants, some is lost immediately as light energy because it is not absorbed by the chlorophyll, and some is lost as heat energy to the environment through respiration and other chemical reactions.	1 mark 1 mark
5 b)	Of the chemical energy that enters the primary consumer level, some is lost immediately as chemical energy in undigested food as faeces, some is lost to the environment as chemical energy in the waste products of reactions such as urea, and some is lost as heat energy to the environment through respiration.	1 mark 1 mark 1 mark
6	A pyramid of number is relatively easy to collect the data for because it is just counting numbers. A pyramid of biomass is more difficult because you need values for the average biomass of each individual of a species to calculate the biomass for each trophic level, which involves killing and drying the organisms. A pyramid of energy is even more difficult to produce because you have to measure the average energy content of an individual of each species, from which to calculate the energy for each trophic level. Measuring energy content involves burning the bodies of the dead organisms in a calorimeter.	1 mark 1 mark 1 mark 1 mark 1 mark
	Total:	39 marks

B4c Cycles within ecosystems

Page 276

1. a) Evaporation is the conversion of liquid water on the Earth's surface to water vapour in the atmosphere.

   b) Transpiration is the evaporation of water from the surface of leaves.

   c) Condensation is the conversion of water vapour in the atmosphere into liquid water droplets in clouds.

   d) Precipitation is the falling of liquid (or solid) water to the Earth's surface from clouds.

2. Route through organisms: drunk by an animal, or absorbed through a plant → water transpired by plant or evaporates from animal's skin → water vapour in atmosphere → condenses in cloud → falls as rain or snow to ground/pond

Non-biological route: water evaporates from pond → water vapour in atmosphere → condenses in cloud → falls as rain or snow to ground/pond

Page 279

1. a) Respiration releases carbon dioxide into the atmosphere from the breakdown of complex carbon compounds inside organisms.

   b) Photosynthesis is the fixing/conversion of carbon dioxide from the atmosphere into complex carbon compounds in plant tissue.

c) Decomposition is the decay/breakdown of dead plant and animal tissue by decomposers, releasing carbon dioxide into the atmosphere during respiration.

2. a) Carbon dioxide

b) Complex carbon compounds

c) Complex carbon compounds

3. Combustion releases carbon dioxide into the atmosphere from complex carbon compounds where the carbon has been locked away for millions of years. This greatly increases the rate at which carbon dioxide is being returned to the atmosphere.

Page 281

1. a) Nitrifying bacteria increase the amount of nitrate ions in the soil by converting ammonium ions to nitrite ions and then to nitrate ions.

b) Nitrogen-fixing bacteria convert atmospheric nitrogen gas directly into a form of nitrogen that plants can use.

c) Denitrifying bacteria reduce the amount of nitrate ions in soil by converting them to nitrogen gas.

2. Nitrifying bacteria increase the fertility of soils because plants can only take in nitrogen in the form of nitrates dissolved in soil water. Without nitrogen the plants will not grow well, and become stunted.

3. Decomposers break down complex nitrogen compounds in dead plant and animal tissues and animal waste. This releases ammonium ions that nitrifying bacteria convert to nitrate ions, which plants need. Without decomposers, the bacteria would have nothing to work on, and the concentration of nitrate ions in the soil would decrease.

Developing investigative skills, page 282

1. Plan should include:

- growing one plant of each kind in each type of nutrient solution
- keeping all plants in identical conditions, i.e. same light, temperature and watering, so that other factors that can affect the rate of growth are controlled
- after several weeks measure growth of each plant, using some suitable measure of growth, e.g. increase in height.

2. Prediction should suggest that the wheat plant with the nitrogen-containing solution will grow better than the one without, but that there is unlikely to be any difference in the two legume plants.

3. Wheat/all nutrients: (20.6 – 5.2/5.2) $\times$ 100% = 296%

Wheat/no nitrogen: (13.6 – 4.8/4.8) $\times$ 100% = 183%

Legume/all nutrients: (18.1 – 3.6/3.6) $\times$ 100% = 403%

Legume/no nitrogen: (19.3 – 4.1/4.1) $\times$100% = 371%

4. The wheat plant with nitrogen grew much more than the wheat plant without. There is no great difference in growth between the two legume plants.

5. The difference in the wheat plants is because the plant in the solution lacking nitrogen cannot get the nitrogen it needs to make proteins etc for healthy growth.

6. The lack of difference between the legume plants is because the plant in solution lacking in nitrogen can get the nitrogen it needs for healthy growth from the nitrogen-fixing bacteria in its roots.

7. Plants that contain nitrogen-fixing bacteria can grow as well in conditions when nitrogen is limited as they can when nitrogen is available, but plants without these bacteria grow less well when nitrogen is lacking.

8. This experiment compares two different kinds of plants, so there may be something about the species that causes the difference. It also only compares one plant in each condition, which will not allow for natural variability between individuals. So some of the results may the affected by chance.

9. Growing legumes of the same species, some that are inoculated with bacteria and some without, in conditions with and without nitrogen, and growing a large number in each situation, would get rid of variation between species and allow for averaging to reduce the effect of random variation between individuals.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1	Notes should include the following: • Water molecule as liquid water in the ocean • Evaporates into the atmosphere as water vapour • Condenses in clouds as liquid water droplets • Fall to Earth as precipitation (such as rain or snow) • Run-off into streams, rivers and back to ocean • Or absorbed by plant root, travels up plant in xylem and a) transpired through leaf back to atmosphere, or b) fixed in glucose by photosynthesis, eaten by animal, etc., until evaporates from animal back into atmosphere	 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
2 a)	Light intensity increases through the morning as the sun rises, and decreases through the afternoon as the sun sets.	1 mark 1 mark
2 b)	As light intensity increases, rate of photosynthesis increases so more carbon is removed from the air due to photosynthesis than is returned by respiration of plants and animals in the forest. As light intensity decreases, rate of photosynthesis decreases until it stops when it is dark. So more carbon dioxide is given off into the atmosphere by respiration of all organisms in the forest, than is removed by photosynthesis.	1 mark 1 mark 1 mark 1 mark
3 a)	Nitrifying bacteria need aerobic conditions, and denitrifying bacteria can grow in anaerobic conditions. Denitrifying bacteria convert nitrogen compounds in soil to nitrogen gas, which escapes to the atmosphere.	1 mark 1 mark 1 mark
3 b)	Plants need nitrogen for healthy growth. Waterlogged soils have low concentrations of nitrates, so plants will grow poorly without another source of nitrogen. Digesting animal tissue releases nitrogen compounds that the plants can use for growth.	1 mark 1 mark 1 mark
4 a)	They are broken down by the action of decomposers. Some of the products of digestion are absorbed by the decomposers and some soak into the ground.	1 mark 1 mark
4 b)	During the winter it is too cold for decomposer organisms to grow so the leaf litter remains on the ground. In spring, when it gets warm again, the decomposer organisms start to grow and break down the leaf litter.	1 mark 1 mark 1 mark

5	All organisms need water in their bodies to transport soluble materials around their bodies,	1 mark
	and to allow cell reactions to take place.	1 mark
	Plants also need water for photosynthesis	1 mark
	and for support.	1 mark
	Water lost from organisms through evaporation and transpiration	1 mark
	cycles back to rivers, streams and soil water through precipitation	1 mark
	from where the organisms can get the water they need again.	1 mark
6	Nitrifying and nitrogen-fixing bacteria are essential for adding nitrates to the soil.	1 mark
	Since plants can only take nitrogen in as nitrates from soil water, without these bacteria the nitrate concentration of soil water would drop,	1 mark
	which would reduce the rate of plant growth.	1 mark
	Less plant growth will provide less food for animals,	1 mark
	eventually leading to starvation and death in the community.	1 mark
	Total:	37 marks

B4d Human influences on the environment

Developing investigative skills, page 289

1. Plan should include the following:

- description of apparatus, including dishes, seeds, absorbent material such as paper towel (to keep seeds moist), dilute solutions of different pH ranging from a low pH (such as pH 2) to a pH at the high end of the normal range (e.g. pH 8)
- description of how to set up apparatus, with a number of seeds in each dish at each pH
- repeat dishes of each pH (to improve reliability of results)
- description of how seeds are monitored and looked after until germination complete (e.g. over 7 days)

2. Use of solutions of low pH should be handled with care and protective goggles worn to prevent splashes entering the eyes. Large water spills should be cleaned up immediately.

3. The graph shows that as pH falls, the success rate of germination is reduced, suggesting that germination in wheat seeds is damaged by acidic conditions.

Page 291

1. a) Smoke/emissions from factories contain acidic gases, such as sulfur dioxide, which dissolve in water droplets in clouds that then fall as acid rain.

   b) The clouds containing the acidic water droplets can be blown over great distances away from the industrial areas by wind.

2. Damage direct to delicate tissues in lungs, of soft-skinned organisms such as fish and amphibians, and of single-celled organisms; indirect damage by changing the acidity of the soil, affecting its fertility due to leaching of minerals, or making poisonous minerals more soluble

Effects as a result to changes in food web may affect other organisms due to interdependency.

3. Carbon monoxide combines with haemoglobin, replacing the oxygen that it normally carries in the blood. Tissues receive less oxygen for respiration, resulting in damage especially in rapidly growing or respiring tissues.

Worksheet B4d.1b

1. Rain that contains dissolved acidic gases such as sulfur dioxide

2. The gases emitted from chimneys rise high into the air and dissolve in water droplets in clouds. The clouds may be blown many miles before the water droplets fall to the ground in precipitation, so pollutant gases from industry in the US could cause acid rain in Canada.

3. Any suitable reasons, such as: closer to areas of heavy industry where air badly polluted, or where most precipitation of that pollution occurs (due to prevailing wind); soil contains only small amounts of neutralising chemicals; heavy snow melt or rainfall deposits larger amounts of acidic compounds than usual

4. Mayfly, because the lowest pH they can tolerate is 5.5

5. Only frogs as they are the only organisms that can tolerate below pH 4.2 of the pond

6. They eat trout and salamanders, which eat mayfly, and mayfly don't tolerate increased acidity. So mayfly numbers would decrease, possibly causing a decrease in salamander and trout numbers, so there would be less food for the eagles.

7. Acid rain can have extremely damaging effects on environments, both where the habitats are natural and where we use the land for human activities such as for growing crops. To reduce our impact on air pollution and acid rain, we must limit the amount of pollutant gases that are released, and legislation is a strong way of doing this.

Page 294

1. The greenhouse effect is a natural process that warms the Earth's surface when greenhouse gases in the atmosphere prevent longer wavelength radiation escaping into space. The enhanced greenhouse effect is the additional warming caused by the addition of greenhouse gases to the atmosphere as a result of human activity.

2. a) Natural: respiration; human: combustion of fossil fuels

   b) Natural: soil bacteria in the nitrogen cycle; human: addition of nitrogen-containing fertilisers to soil

   c) Natural: digestion of food in animal guts and decay of waterlogged vegetation; human: increase in herd animals and artificial waterlogged vegetation in rice paddy fields

3. Any from: increase in number and intensity of storms, more drought, more flooding, change to summer/winter temperatures and precipitation

Worksheet B4d.2a

1. Make sure students have the standard graphs for this answer, showing a rapid increase in temperature and in carbon dioxide concentration over the past 50 years or so.

2. Temperature recently from direct measurements at fixed sites, more distantly some are direct measurements (such as in the UK and US), others are calculated from proxies such as tree ring data and ice core data; carbon dioxide concentration since late 1950s at Mauna Loa, previous to that from bubbles in ice cores

Using proxies makes assumptions about the relationship between the proxy and the value being calculated, which can reduce the reliability of the calculated value.

3. Graphs should show: gradual rise since c. 1750; an increasingly rapid rise in past 50 years or so

4. That increasing carbon dioxide in the atmosphere released from human activity is enhancing the greenhouse effect and causing global temperature to rise.

5. Much of the work has been centred on lab experiments, and in particular computer modelling.

6. The correlation is very close, and other natural factors have failed to produce good correlations with temperature, so it is becoming increasingly reasonable to accept this cause.

7. Many of the emissions come from industrial processes, or transport. Reducing emissions means persuading people to change what they do, which can be very expensive and difficult to achieve. While there is apparently doubt in the discussion, politicians and industry have used this as an excuse not to face difficult and costly decisions.

Page 297

1. The addition of nutrients to water

2. Runoff of fertiliser into water as a result of heavy rainfall, leaching of soluble nutrients in fertiliser through soil into water systems

3. Sewage added to water → adds nutrients to water = eutrophication → plant and microorganism growth rate increases → respiration rate of microorganisms increases, removing dissolved oxygen from water → less dissolved oxygen for other organisms that die = water pollution

Page 298

1. They are decomposers.

2. Because the microorganisms are aerobic. If conditions became anaerobic, then other microorganisms would grow and the materials in the liquid would not be broken down in the same way. Some of these anaerobic microorganisms might be pathogenic, which would make the water more dangerous for release into water systems.

3. The microorganisms digest the organic molecules in the sewage, causing them to break down into smaller inorganic molecules such as carbon dioxide and nitrate ions.

4. The microorganisms that produce methane are anaerobic.

5. Dried sludge still contains large amounts of organic nitrogen. When this is added to fields, it is broken down by bacteria to release inorganic nitrogen in a form that crop plants can absorb. The plant use these for making proteins and other nitrogen-containing organic molecules, so the sewage improves crop growth.

6. The chlorine kills any microorganisms left in the water, so that none are added to the water system.

7. The BOD of sewage is high because microorganisms can use the nutrients in it to grow and multiply rapidly. So respiration rate is high and the amount of oxygen taken from the water by the microorganisms is high. The BOD of treated water is low because the nutrients in sewage have been broken down to a form that doesn't encourage growth, or absorbed by the microorganisms in the treatment beds and used for their growth.

Worksheet B4d.3a

1. For respiration, because most are adapted from extracting oxygen from water not from the air

2. Different organisms either have different adaptations for extracting oxygen, some of which are better than others (e.g. haemoglobin in bloodworms), or need different amounts of oxygen (e.g. organisms that are sessile/stationary will need less energy from respiration than active predators, and so will need less oxygen).

3. Oxygen concentration generally decreases as the level of nutrients in water increases, because this stimulates the growth of aquatic plants and bacteria, increasing the amount of oxygen taken from the water for respiration.

4. Leeches, because lower score means need lower amount of oxygen, as found in more polluted water

5. Quicker to do, gives more accurate measure of oxygen

6. Sensor only gives immediate oxygen concentration, and this may vary over time due to changes in nutrient supply, water flow, turbulence in water etc. Measuring organisms gives a longer-term picture of the quality of the water.

7. Take samples at different places along the river, and identify the point at which BMWP score drops. The source of the pollution should be upriver, between this and the sampling point where pollution was not indicated.

Page 299

1. a) Deforestation: the destruction/cutting down of large areas of forest and woodland

   b) Soil erosion: the washing away of soil by heavy rainfall

   c) Leaching: when soluble nutrients dissolve in soil water and soak away deep into the ground

2. a)Trees take up water from the ground and release it to the atmosphere through transpiration, which affects the moisture in the air above the forest and affects the water cycle.

   b) Soil erosion, because there are no tree roots to hold the soil, and increased leaching because there are few plant roots to absorb the nutrients; both remove soluble mineral nutrients from the soil, which will reduce the rate of plant growth

   c) Burning or rotting of trees releases the carbon stored in the wood as carbon dioxide to the atmosphere at a much faster rate than normal, increasing atmosphere carbon dioxide.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Pollution is the harming of the environment by the addition of substances.	1 mark
1 b)	Burning of fossil fuels in industries/power stations;	1 mark
	burning of petrol/diesel in vehicle engines	1 mark
1 c)	Sulfur dioxide dissolves in water droplets in clouds to form sulfuric acid.	1 mark
	When precipitation/rain falls from the clouds, it contains the sulfuric acid, making it more acidic than normal.	1 mark
1 d)	Sketch like the diagram on page 287 of the Student Book showing sulfur dioxide gas emissions from chimneys/traffic rising into air	1 mark
	dissolving in clouds to form acidic water droplets and clouds being blown far from the region of emission,	1 mark
	and acid rain falling on a distant region.	1 mark
1 e)	As a gas it can damage breathing surfaces.	1 mark
	As acid rain, it can acidify land and water and damage organisms that come into contact with it.	1 mark
2 a)	To increase crop growth	1 mark
2 b)	Some of the fertiliser will not be used by the plants, and so it will escape into the water system/nearby streams or rivers.	1 mark
2 c)	Fertiliser in the water will increase the nutrients so plants and algae will grow faster.	1 mark
	This will cover the surface of the water, blocking light from reaching plants deeper in the water.	1 mark
	Plants lower down will die, which will increase the number of microorganisms in the water as they decay the plants.	1 mark
	Respiration of the microorganisms removes oxygen from the water,	

	decreasing the oxygen available for other organisms that might die.	1 mark
2 d)	If farmers only add enough fertiliser to the soil as the plants can absorb, then this will reduce the amount of run-off and leaching of minerals into the streams and rivers around the fields. This will reduce the amount of eutrophication of the water and reduce the risk of depletion of dissolved oxygen in the water.	1 mark 1 mark
3 a)	The oxygen is used by the microorganisms in the water for respiration.	1 mark 1 mark
3 b)	Polluted water would use more oxygen because it contains a greater number of microorganisms.	1 mark 1 mark
3 c)	Worms because they can survive better in conditions of low oxygen as the result of water pollution.	1 mark 1 mark
3 d)	It means the organism has characteristics that enable it to survive and reproduce well in that habitat.	1 mark
3 e)	The organisms have to live in the water all the time, so they will show the condition of the water over a long period. Sampling for oxygen demand only gives a result for the time that the water was sampled, and it may change from one period to another.	1 mark 1 mark
4 a)	To clear the land for building or growing crops/keeping herd animals, and to use the timber for construction and woodwork.	1 mark
4 b)	Large-scale deforestation destroys many habitats for plants and for animals. This means that the organisms that used to live there are unlikely to be able to live there any longer. Other organisms that are better adapted to the new conditions will move in.	1 mark 1 mark 1 mark
4 c)	After deforestation, mineral nutrients that were locked up in the trees are lost or released. Soil erosion and leaching removes dissolved minerals from the layers of the soil where plant roots can reach, so the soil loses fertility. This means that new plants cannot grow as quickly as they did before the area was deforested.	1 mark 1 mark 1 mark
5	Evidence from measurements show that the Earth's surface temperature is increasing at a faster rate than ever before. Carbon dioxide concentration in the air is also increasing, probably as a result of human activities, as are other greenhouse gases. An increase in these gases in the atmosphere could cause an enhanced greenhouse effect leading to global warming.	1 mark 1 mark 1 mark
	Total:	37 marks

Section 4: Exam-style questions mark scheme

Question	Correct answer	Marks
2 a)	i) Brazil: 43.9	1 mark
	Colombia: 46.7	1 mark
	French Guiana: 10.0	1 mark
	Peru: 45.3	1 mark
	Suriname: 9.2	1 mark
	Venezuela: 47.7	1 mark
	ii) greatest: Venezuela	1 mark
	least: Suriname	1 mark
	iii) Two of the following: timber agriculture/crop plantations/grazing area for cattle mining	1 mark for each – 2 marks maxiumum
2 b)	**Soil erosion:** without the protective cover of trees and other vegetation, rain washes away the soil	1 mark
	Leaching: nutrients are lost from the habitat as without tree roots to absorb them and lock them away	1 mark
	they are washed away when it rains	1 mark
	nutrients are also removed by soil erosion	1 mark
	The water cycle: trees would normally take up water from the ground and release it to the atmosphere through the process of transpiration	1 mark
	with deforestation, less water ends up in the atmosphere and there is a decrease in rainfall	1 mark
	owing to the lack of trees, the soil is less able to cope when it rains heavily, and run off from the soil increases	1 mark
	Atmospheric oxygen and carbon dioxide: trees take up carbon dioxide for photosynthesis and form a major carbon store	1 mark
	They release oxygen into the air.	1 mark
	As trees are felled, then burned or left to rot, the carbon is released as carbon dioxide (1)	1 mark
	This rapidly increases the carbon dioxide in proportion to the oxygen (1)	1 mark
3 a)	i) microscopic algae	1 mark
	brown seaweed	1 mark
	ii) topshell	1 mark
	limpet	1 mark
	periwinkle	1 mark
	iii) crab	1 mark
	dog whelk	1 mark
	gull	1 mark

3 b)	From the Sun's energy falling on a leaf, plants only convert a maximum of 1–2% of this light energy into chemical energy in biomass.	1 mark
	Energy is lost as it is transferred from one trophic level to the next	1 mark
	through respiration, excretion, egestion (undigested food) and heat.	1 mark
	The rate of transfer from one level to another is only 5-20% (depending on the organisms involved).	1 mark
	Although an organism at the next level eats a large number of organisms of the level below, length is limited by the energy remaining at higher trophic levels.	1 mark
3 c)	i) feed on brown seaweed	1 mark
	obtain protection/shelter from brown seaweed or any sensible suggestion	1 mark
	ii) place a transect line, e.g. a tape measure down the seashore	1 mark
	starting at high water and extending down the shore	1 mark
	at intervals of 10 m, put a quadrat	1 mark
	of suitable area, e.g. 0.5 × 0.5 m, on the line	1 mark
	count the numbers of periwinkles in the quadrat	1 mark
	repeat across the beach at that distance	1 mark
	calculate the mean number of periwinkles per m^2 for each distance	1 mark
4 a)	i) **Carbon dioxide** from the atmosphere is converted to complex carbon compounds in **plants** by the process of **photosynthesis**. This is often called carbon **fixation**.	1 mark 2 marks 1 mark
	Plants are then often eaten by **animals**, which build up their own complex carbon compounds.	1 mark
	The process of **respiration**, in both plants and animals, returns some of this carbon back to the atmosphere as **carbon dioxide**.	1 mark 1 mark
	When organisms die, their bodies decay as they are worked on by **decomposers**. Some of the complex carbon compounds are taken into the bodies of these organisms, where some may be converted to carbon dioxide during their **respiration**.	1 mark 1 mark
	ii) combustion	1 mark
4 b)	A: nitrogen-fixing	1 mark
	B: decomposers	1 mark
	C: denitrifying	1 mark
	D: nitrifying	1 mark
5 a)	i) Sewage concentration shows a steady increase from 2006 to part way through 2009, then the increase accelerated	1 mark
	The oxygen concentration was stable from 2006 to 2007, showed a sharp decrease through to 2009, then the rate of decrease slowed down towards 2010	1 mark
	ii) Because of its organic content	1 mark
	sewage is fed upon/used for the respiration of bacteria/microorganisms in the water	1 mark
	the bacteria/microorganisms use oxygen for respiration, so this is removed from the water	1 mark

5 b)	Trout are most sensitive to low oxygen concentration	1 mark
	and their population in the river dies first.	1 mark
	Perch show a steady decrease, but then their population decreases rapidly as the oxygen reaches a certain level.	1 mark
	Some perch are tolerant of low oxygen concentrations, so their population does not completely die out.	1 mark
	Carp are most tolerant of low oxygen concentrations and their numbers increase as oxygen concentrations fall.	1 mark
	As oxygen concentrations reach a certain level, carp numbers start to level off.	1 mark

Section 5 Use of biological resources

B5a Food production

Page 315

1. Any four of the following: temperature, carbon dioxide, light, water, pests

2. For each of the factors mentioned in question 1:

- optimum temperature allows enzymes to work at fastest rate, so maximising rate of growth
- carbon dioxide is usually a limiting factor in photosynthesis, so increasing carbon dioxide concentration in the air around the plants should increase the rate of photosynthesis and therefore growth
- light is needed for photosynthesis, so by keeping light levels high enough for photosynthesis throughout the day and night will increase the amount of growth of the plants
- plants need water for photosynthesis and for the transport of soluble materials, so having the right amount of water all the time will increase the rate of growth
- pests damage plants, limiting the rate of growth, so removing pests should increase growth

3. Polytunnels help to protect a crop from the environment, because conditions inside them can be more controlled. So using polytunnels can make it possible to grow crops where it may normally get too cold at night or in cooler seasons, or where it gets dark early in the evening, etc.

Page 317

1. To add nutrients to the soil so that the plants grow bigger and produce more yield to harvest

2. Planting different crops in the same field at different times, to use different nutrients and to add nitrogen back to the soil when legumes are planted.

3. Natural fertilisers include manure, guano and dried sludge from sewage treatment. Artificial fertilisers are made from chemicals in industrial processes.

Page 320

1. They damage the plants so that they don't grow as quickly, so they don't produce as much yield.

2. It will keep the predator/parasite in the same place as the pest and so maximise predation/parasitisation of the pest. It will also reduce the chance of new pests getting to the crop.

3.

	Advantages	**Disadvantages**
Pesticides	removes large proportion of pests quickly easy to apply	pests may develop resistance may damage other species may result in greater numbers of pests (if predators killed)
Biological control	less likely for pest to develop resistance usually better targeted at pest so less damaging to other species (except for introduced species) very good within closed spaces, such	slower to act than chemicals introduced predators/parasites may cause more problems to the environment and be difficult to control

	as glasshouses	

Page 321

1. Pesticide use increased greatly from less than 1000 tons per year to over 25 000 tons in 1995.

2. Yield generally increased from about 350 kg/ha in 1980 to a maximum of nearly 800 kg/ha in 1991. After this it fell to between 500 and 600 kg/ha.

3. Yield may have increased from 1980 to 1991 as pesticide use increased and controlled the whitefly. However, increasing pesticide use after that did not prevent a decrease in yield, suggesting that the whitefly were becoming resistant to the pesticide.

4. As the prey numbers increase, the predators have more food and so can produce more young.

5. Increasing pesticide use killed predators as well as pests. So, as pest numbers increased after the pesticide had lost effect, there were too few predators to control them.

6. As whitefly become resistant to the pesticide, they are unaffected by it. But their predators are still killed by its use. So the whitefly numbers can increase even further, which will increase the transmission of the virus that damages the cotton.

7. Using pesticides specific for whitefly will not kill the predators, so a combination of predators and chemicals can be used to keep the whitefly numbers under control so that damage to cotton is reduced and yield increases.

Page 323

1. Any four suitable foods, such as beer, other alcoholic drinks, vinegar, bread, cheese, yoghurt.

2. It converts sugars to alcohol/ethanol.

3. Milk → pasteurised to kill microorganisms → inoculated with *Lactobacillus* → bacteria convert lactose to lactic acid → lactic acid causes milk proteins to coagulate and form yoghurt

Developing investigative skills, page 324

1. To prevent air getting into the mixture, because yeast only forms ethanol in anaerobic conditions.

2. Reactions are carried out faster in warm conditions. So respiration will be faster than if at room temperature.

3. Carbon dioxide released during anaerobic respiration.

4. The tube that rose up the most was the one with no additional alcohol. As more ethanol was added, the height that the tube rose was reduced.

5. The greatest carbon dioxide production, and so the greatest amount of respiration, was the in tube without additional ethanol. With the other tubes, the rate of carbon dioxide production (and so rate of anaerobic respiration) decreased with increasing amounts of additional ethanol.

6. Ethanol inhibits the rate of respiration by yeast in anaerobic conditions. The more ethanol there is in solution, the more that respiration is inhibited.

7. Repeat the experiment with a range of smaller amounts of ethanol added, to find the smallest amount of additional ethanol that shows a reduction in carbon dioxide production.

Page 326

1. A large vessel in which microorganisms are grown in large numbers under controlled conditions

2. a) Temperature, pH, oxygenation, nutrient concentration.

   b) Temperature will increase due to the reactions of respiration and other reactions of the microorganisms. If temperature rises too high, it may reduce rate of growth or kill the microorganisms.

pH may change because of substances released by the microorganisms into the solution. This may reduce rate of growth.

Oxygen concentration might fall as oxygen is used for respiration. Microorganisms are aerobic, so rate of growth will reduce if oxygen concentration falls.

Nutrient concentration will fall as microorganisms use nutrients to make new cells. Rate of growth will fall if nutrients are not added to replace what is used.

3. a) Keeping things sterile

b) It prevents other microorganisms growing rapidly in the fermenter and competing with the added microorganisms.

Page 329

1. Keeping fish in contained areas, improving growing conditions to increase the rate of growth, and harvesting the fish

2. Any three from the following: quality of water, food supply, predators, stocking limit, pests and diseases

3. For each factor given in Q2:

- to prevent build-up of fish waste and uneaten food, and to provide as clean a water supply as possible
- to provide food of the right sort at a high enough rate to maximise growth
- to prevent predators killing fish
- to prevent intraspecific predation in farmed fish that are carnivorous
- to prevent pests and diseases from harming fish and so reducing the rate of growth or killing them

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Carbon dioxide concentration in the air	1 mark
1 b)	The weight of lettuces and plants is greater with additional carbon dioxide than without.	1 mark
1 c)	Carbon dioxide is used in photosynthesis to make sugars, which are used in the plant to make new plant tissues.	1 mark 1 mark
1 d)	Temperature because plants grow faster when it is warm but more slowly if the temperature is too high. Water because plants need water for photosynthesis. Nutrients because plants grow faster with enough nutrients than without.	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
1 e)	Farmers must consider the cost of setting up and using glasshouses, including extra watering, control of temperature, etc., compared with growing crops in open fields where water comes from the environment. They need to compare the costs with the extra money made by the greater yield from glasshouse crops, and decide if the difference is worth the money and extra effort.	1 mark 1 mark 1 mark

2 a)	Leaves photosynthesise and make sugars, some of which are converted to other substances that are needed to make new cells. So if large amounts of leaf are removed from a plant it cannot make as much sugars and cannot make as many new cells including the part we harvest (the yield).	1 mark 1 mark
2 b)	The stem contains the xylem, which takes water up to the leaves for photosynthesis. So damaging the xylem would reduce photosynthesis and the food available for making new cells. The stem also contains the phloem, which transports the sugars from the leaves to other parts of the plant. So damaging the phloem would prevent sugars being transported to other parts of the plant where they can be used to make more cells.	1 mark 1 mark 1 mark 1 mark
3 a)	Benefits: probably only needs one introduction as predator numbers will increase until they control the pest numbers. So there is potentially less effort and less cost than with pesticides, which need to be applied more than once.	1 mark 1 mark
3 b)	Risks: if introduced predator prefers other species, it won't control the pest and instead causes damage to the food web. If predator doesn't have its own predator to control its numbers, it will be difficult to control if its numbers increase too high.	1 mark 1 mark
4 a)	glucose → alcohol (ethanol) + carbon dioxide	1 mark
4 b)	It makes the dough rise/become soft and fluffy.	1 mark
4 c)	Because bubbles of carbon dioxide produced by respiration are trapped in the sticky dough.	1 mark 1 mark
4 d)	Any one suitable answer, such as: alcoholic drinks (e.g. beer); cheese; yoghurt; single cell protein	1 mark
5 a)	i) Can be done in a smaller space; fish produce more protein for food eaten because they are 'cold-blooded'; conditions for maximum rate of growth are easier to control; fewer greenhouse gases (such as methane from digestion) produced. ii) May damage the local environment; predator fish still need food produced from wild fish, so doesn't reduce damage to wild food stocks as much as hoped.	1 mark 1 mark 1 mark 1 mark 1 mark 1 mark
5 b)	i) Antibiotics kill or stop bacteria growing; pathogenic bacteria can harm the fish and so reduce their growth rate. ii) Using antibiotics increases the chance of developing resistance of bacteria to the antibiotics; this increases the problem of trying to control bacterial infections with antibiotics and increases the risk of people dying from these infections.	1 mark 1 mark 1 mark 1 mark
5 c)	Fish farming is not sustainable at present because pollution from tanks damages the local environment and wild fish stocks are still being depleted to provide food for farmed fish such as salmon and seabass.	1 mark 1 mark

	Keeping herbivorous fish in specially built tanks is more sustainable because damage to the environment is much easier to limit.	1 mark
	Total:	41 marks

B5b Selective breeding

Page 337 (top)

1. a) Characteristics that can be bred for in selective breeding programmes are those that are controlled by genes.

   b) If the desired characteristic is not controlled by a gene, it cannot be selectively bred for.

2. Any three from: increasing size of part that we eat; decreasing size of parts we don't eat; improving pest and disease resistance; improved growth in adverse conditions

3. For each of the factors included in question 2:

- the part of the plant we eat is what is measured as the yield
- decreasing other parts means the plant has more energy to grow the part we do eat
- diseases and pests damage the plant so it doesn't grow as well as it could, so making plants resistant will help them to grow faster
- adverse conditions (such as heat or drought) slow the rate of growth, so improving growth in these conditions will help to improve yield where these conditions happen

4. Because people like different plants, and new varieties of plants are often considered more attractive than old varieties.

Page 337 (bottom)

1. In sexual reproduction, the offspring inherit half their alleles from one parent and half from the other. In selective breeding, only a few parent types are used for breeding. So this limits the range of variation in the alleles in the parents. So the offspring can only inherit from this limited range.

2. This means that when they cross-breed in the field, the seed produced is more likely to contain the characteristics that they have been bred for. Some of that seed planted in the following year will produce plants that still show the required characteristics.

3. The environment is continually changing, and may change a lot over the next century or so as a result of climate change. This means that characteristics that are useful now, may be less important than others in the future, such as the ability to withstand drought (if the climate gets hotter and drier in some places), or resistance to particular pests or diseases that are not common now by may become more common as climate changes. If the varieties we are growing do not have these characteristics, then crop yield will be reduced as growth of the crop plants is reduced.

4. Any suitable answer with appropriate justification, such as: in the short term this doesn't seem to make sense because we need to grow enough food for everyone to eat, but in the long term it does make sense because the environment changes and we cannot predict how it will change and what characteristics we will need for crops in the future.

Page 339

1. Choose male and female animals with characteristics that are nearest to the desired characteristic. Breed them. From the offspring, select individuals with characteristics that are nearest to the desired characteristic. Breed them. Repeat this for enough generations until you have individuals with the desired characteristic.

2. a) Muscle is the meat that we eat. So this is increased yield.

b) Disease harms the animal so that it grows more slowly, or may even die. Resistant animals will grow better and need less treatment for infections with chemicals such as antibiotics.

c) Docile animals are easier to handle and move around, which makes them easier to work with.

3. Different breeds of sheep have different characteristics that are often linked to their local environment, or whether they are farmed for meat or milk, so there cannot be one breed that is suited to all environments and is equally good for meat and milk.

Worksheet B5b.1b

1. Both show an increase in growth/weight over time, but the meat chicken grows faster, with a mass of nearly 2400 g in 45 days, while the layer chicken only reaches a mass of about 600 g in the same time.

2. So that the only difference in the experiment was breed, and any variation in results would be the result of breed only

3. The meat chicken breed puts more of the energy from its food into producing new muscle tissue. The layer breed puts less energy into muscle tissue and more into producing eggs.

4. The graph shows that the increase in size of meat chickens is just the result of selective breeding, not additional chemicals.

5. a) Growing a meat chicken that produces more meat faster means the farmer will get more money for the animals when he sells them to a supermarket.

b) Growing a layer chicken that puts less energy into making new body tissue and more into the eggs it produces, means that it will lay more eggs and the farmer will get more money for them.

6. The farmer would select a cockerel from an egg laid by a hen that lays large eggs and mate it with a different female that lays large eggs. He would select the hens from the offspring that lay the largest eggs and mate them with a different cockerel that came from an egg laid by a large-egg female. This would be repeated for many generations until the farmer could reliably produce larger eggs from the chickens that he is breeding.

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	It can improve crop yield, or taste, or some other characteristic that makes it more valuable.	1 mark
1 b)	It can take a long time (because it can take many generations to produce a new variety). It may produce new varieties that have the desired characteristic but are more susceptible to other problems.	1 mark 1 mark
2	She could take the pollen from one plant and use it to pollinate the other plant. She should then plant the seed that is produced and wait until the new plants have grown and produced flowers. Then she will need to repeat the process, possibly many times, until she gets several plants with large red flowers so that she can guarantee producing plants that only have large red flowers when she breeds them together.	1 mark 1 mark 1 mark
3 a)	So that they produce more meat (or another characteristic that is useful, such as milk or wool)	1 mark
3 b)	Because the European or Australian breeds are not adapted to the harsh conditions in India, so they will not grow as well.	1 mark 1 mark

3 c)	Selectively breed from individuals of the European breed, which produce the most meat, with individuals from the Indian breed that are best able to withstand the local conditions. Grow the lambs that are produced, then breed individuals that show the best combination of meat production and hardiness. Repeat the selection and breeding until there is a flock of sheep that show good meat production and tolerance of heat.	1 mark 1 mark 1 mark
4 a)	They can reproduce together to produce offspring.	1 mark 1 mark
4 b)	By a mutation of a colour allele.	1 mark
4 c)	The fish are kept for display, so breeds that look very different from others could be more desirable for showing off.	1 mark 1 mark
	Total:	17 marks

B5c Genetic modification

Page 345

1. a) An enzyme that cuts DNA/genetic material at a specific site

   b) An enzyme that joins two pieces of DNA/genetic material

   c) Something that carries genetic material into the nucleus of another cell

2. Required gene extracted from DNA of organism and cut open using a restriction enzyme → bacterial plasmid removed from bacterium and cut open with same restriction enzyme → required gene and plasmid mixed together with ligase enzyme → ligase enzyme joins inserted gene and plasmid together → plasmid inserted into another bacterium → inserted gene produces new characteristic (such as production on human insulin) in bacteria

3. Because the human insulin gene has been inserted into the bacterial DNA, and is decoded by the bacterial cell exactly as it would be in a human cell, producing human insulin.

Page 347

1. Required gene inserted into bacterial plasmid → plasmid inserted into bacterium → bacterium infects plant cell and inserts plasmid into cell nucleus → required gene inserted into plant DNA → plant cell cultured to divide to produce new plant → all cells in plant produced by mitotic division of original cell, so all cells are identical and contain a copy of the inserted gene

2. Insertion of a gene for pest resistance, to kill caterpillars that try to eat the plant

3. Any one of each of the following:

Advantage: reduces need for pesticide (so less damage to environment), reduces time needed to look after crop (so reduces cost), farmer doesn't risk health from spraying pesticides

Disadvantage: seed is more expensive, gene may transfer to wild plants and potentially affect the food web, there may be health concerns with the food produced from the crop

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	This means that if the virus contains a gene that has been inserted from another organism, it should insert that gene into the cell in a way that means the cell will decode that gene and produce the characteristic.	1 mark
1 b)	The viral genes that cause illness must be removed, so that they do not harm the transgenic organism.	1 mark
2 a)	A sheep that contains a gene from another organism	1 mark
2 b)	A vector	1 mark
2 c)	Restriction enzymes are used to cut the gene out of the human DNA and to cut the vector open. Ligase enzyme joins the human gene to the vector DNA.	1 mark 1 mark 1 mark
2 d)	It can be produced in much larger quantities. It is not at risk of carrying blood-borne human pathogens.	1 mark 1 mark
3 a)	To make people take notice – people are less likely to read something that looks boring.	1 mark
3 b)	The headline is suggesting that transgenic plants are dangerous. This could be as a result of eating food produced from the plants, although there is no clear evidence of this yet. They could also be dangerous as a result of damaging the environment by gene transfer through pollination to wild plants. Again, there is little evidence of this at the moment. Although there is no evidence for either of these possible dangers it could happen, so we need to be cautious.	1 mark 1 mark 1 mark 1 mark
4 a)	Answer that includes reference to crossing two varieties, one with high yield and one with disease resistance selecting individuals with the best characteristics and cross-breeding them, and repeating this until you have individuals with the right characteristics.	1 mark 1 mark
4 b)	Insert a gene for disease resistance from another organism into a high-yielding crop variety.	1 mark 1 mark
4 c)	Takes a long time to produce a new variety by selective breeding, much slower than using GM techniques.	1 mark
4 d)	Any suitable answer with appropriate explanation, such as: gene for resistance might be transferred to other wild plants as a result of pollination.	 1 mark 1 mark
	Total:	21 marks

B5d Cloning

Developing investigative skills, page 353

1. Plan should include the following:

- taking tiny pieces of plant material from shoot tips
- sterilising of explants and of all equipment used
- producing nutrient medium with correct balance of nutrients and hormones to stimulate growth and differentiation of cells to form tiny plants
- placing explants on nutrient medium, keeping sterile, then growing in idea l conditions of light and humidity to encourage rapid growth
- when tiny plants large enough, moving into small compost pots, and looking after them until fully established.

2. Sterilisation kills microorganisms that would grow well on the nutrients and in the humidity needed for the plants. They could quickly overgrow the explants or infect them, so the project would fail.

3. a) They will be identical.

b) Because they have the same genes in their cells.

Page 353

1. Micropropagation: The cultivation of explants (small pieces of plant tissue) in the lab to create many clones of the original plant

2. Explants taken from parent plant and sterilised → explants placed on nutrient medium containing chemicals for growth as well as hormones → hormones stimulate growth and differentiation to produce roots, stems and leaves → when large enough to handle, the tiny plants are moved onto different nutrient media → when large enough, moved into pots of compost

3. They are all produced by the mitotic division of the cells from the original plant so they all contain the same genes.

Page 356

1. A diploid cell taken from an adult sheep → nucleus removed and placed in an enucleated egg cell from another sheep → cell stimulated to start dividing to produce embryo → embryo placed in the uterus of another sheep to develop ready for birth

2. Sheep B, as the diploid nucleus contains the genes that code for the characteristics of Dolly

3. a) Any two from the following:

research into human diseases

production of chemicals (e.g. antibodies) to treat human diseases

production of organs for transplant into humans

b) Any two from:

may cause problems for the animal, such as early onset of age-related disease

may be too expensive

may transfer diseases

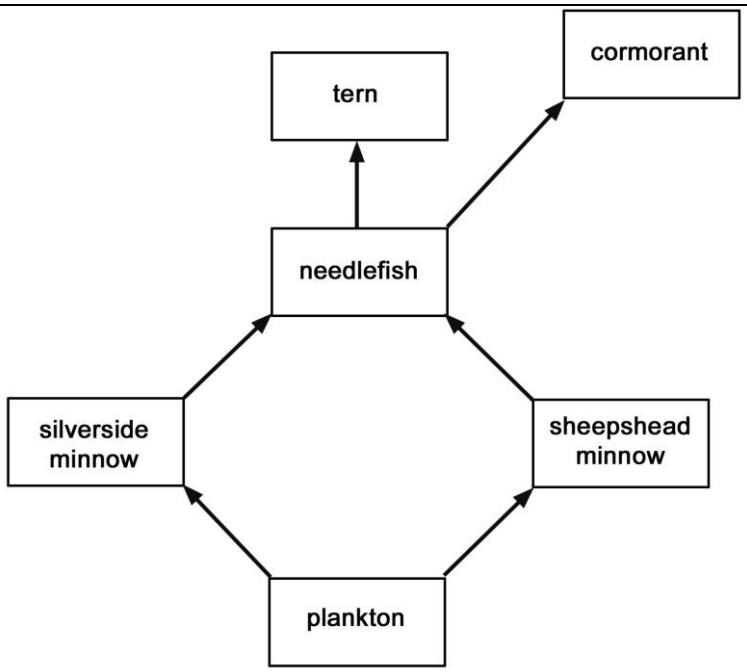
some people think it is unethical

End of Topic Questions mark scheme

Question	Correct answer	Marks
1 a)	Sexual reproduction of disease-resistant plant with plants of the same species with flowers of different colours	1 mark
	This should produce variation in the offspring.	1 mark
1 b)	Cloning by micropropagation,	1 mark
	as all the offspring will be clones of the parent plant and have the blue flowers.	1 mark
2 a)	It would provide more organs	1 mark
	so that more people could be treated and fewer people die due to organ failure.	1 mark
2 b)	The animals are being produced just for treating humans, so some people object to this.	1 mark
	Also it costs a lot to produce organs this way.	1 mark
	It may carry diseases into the patient.	1 mark
3 a)	They grow from the old plant, in the same soil, so if the soil and old plant are infected, it is very likely that the new plant will be too.	1 mark
3 b)	As infection spreads through plantations, more plants are diseased and produce fewer fruit.	1 mark
3 c)	Take cells from the growing tip of a banana plant, and sterilise them.	1 mark
	Place the cells on a sterile nutrient medium that contains plant hormones to encourage the cells to grow.	1 mark
	Place the explants on a nutrient medium containing plant hormones that encourage the cells to differentiate and produce roots, shoots and leaves.	1 mark
	Grow the tiny plants until large enough to handle for transplanting into pots.	1 mark
3 d)	By taking only a few cells from the tip of the plant for tissue culture, it is easier to take cells that are uninfected by pests and diseases.	1 mark
	If plants are uninfected, they will grow better and produce a greater yield of fruit.	1 mark
3 e)	All the cells in the transgenic plant will contain the resistant gene	1 mark
	so plants grown by tissue culture will all contain the resistant gene in all their cells,	1 mark
	because this is a form of asexual reproduction so all cells are identical.	1 mark
	Total:	20 marks

Section 5: Exam-style questions mark scheme

Question	Correct answer	Marks
2 a)	i) glucose →	1 mark
	ethanol + carbon dioxide	1 mark
	ii) Yeast cells produce the enzymes for the (series of) chemical reactions involved.	1 mark
2 b)	i) Prepare a mixture of yeast, glucose and water and place in a boiling tube.	1 mark
	Connect the bung in the boiling tube to a gas syringe using a delivery tube.	1 mark
	Place the mixture in a water bath at 20 °C.	1 mark
	Record the volume of carbon dioxide produced in a given time, e.g. 30 minutes.	1 mark
	Repeat the investigation at different temperatures, e.g. 30 °C, 40 °C, 50 °C.	1 mark
	5 marks for any other suitable method.	
	ii) Any two of the following:	1 mark for each point
	Concentration of sugar	
	Concentration of oxygen	
	pH	
	Type of sugar	
2 c)	malted barley	1 mark
	hops	1 mark
	water	1 mark
3 a)	i) Food web as shown	1 mark for each box with arrow.

	 ii) To meet its energy/food needs, each organism eats many individual organisms on the trophic level below DDT is retained by each organism in the food web (and not excreted, respired or broken down) So the DDT becomes concentrated as it moves up the trophic levels	1 mark 1 mark 1 mark
3 b)	The reproduction of the birds is affected, so there will be a reduction in the populations of cormorants and terns the population of needlefish will increase so, as they eat the minnows, the minnow populations will fall numbers of needlefish will then fall numbers of plankton increase to such extent that as they die, feeding of microorganisms will reduce the oxygen in the water, leading to the death of other organisms.	1 mark 1 mark 1 mark 1 mark 1 mark
4 a)	Fish are: high in protein low in fat/high in essential fatty acids	1 mark 1 mark
4 b)	**Water quality**: in open systems: maintained by moving water through the pond, lake or sea tank/location chosen so water quality can be relied on throughout the year to contain sufficient oxygen and to be clear of silt and chemicals **or** in closed systems: waste products from the fish and left-over food are removed on a continual basis/ponds need to be emptied on a regular basis and cleaned out **Control of pests and diseases**: pesticides to control pests and antibiotics to control disease. **Control of predation**: Interspecific predation must be prevented by protecting the fish from birds and mammals, e.g. otters, by placing netted or metal cages over the ponds	1 mark 1 mark 1 mark

	or intraspecific predation prevented by keeping the fish at lower density	
4 c)	i) In 1985: 34 600 tonnes (1)	1 mark
	Working out: nitrogen waste per fish = 77.5 kg = 0.0775 tonnes	1 mark
	2683 tonnes of waste are produced,	
	therefore number of fish that produce this mass of waste = 2683/0.0775 = 34 600 (3 sig. fig.)	
	In 2007: 814 000 tonnes	1 mark
	Working out: nitrogen waste per fish = 50.2 kg = 0.0502 tonnes	1 mark
	40 877 tonnes of waste are produced,	
	therefore number of fish that produce this mass of waste = 40 877/0.0502 = 814 000 (3 sig. fig.)	
	ii) Nitrates/nitrogen compounds cause eutrophication of water	1 mark
	resulting in a population growth of algae	1 mark
	these respire and deprive the water of oxygen (only the uppermost layers photosynthesise and add oxygen to the water)	1 mark
	the death of the algae further deprives the water of oxygen as bacteria feed on them and respire	1 mark
	the organisms in the water will die.	1 mark
5 a)	*Lactobacillus* (*delbrückii bulgaricus*)	1 mark
	Accept also *Streptococcus thermophilus*	
5 b)	i) There is a rapid fall over the first five hours from a pH of 6.6 to 4.7	1 mark
	then a slow fall/fairly constant pH from five hours to 15 hours to a pH of 4.4	1 mark
	ii) lactic acid is produced by the bacteria	1 mark
5 c)	high temperature/temperature of 45 °C	1 mark
6	gene	1 mark
	restriction	1 mark
	ligase	1 mark
	recombinant	1 mark
	vectors	1 mark
7 a)	in the soil	1 mark
7 b)	The insecticide may also kill beneficial butterflies and moths as well as those that are harmful to crops	1 mark
	and these insects are important pollinators.	1 mark
7 c)	a gene gun	1 mark
7 d)	wind-pollinated	1 mark
	the pollen is sufficiently light to be blown in the wind	1 mark
7 e)	In principle, the GM maize should be an effective way of controlling insect pests of maize as the Insecticidal Crystal Proteins (ICP) are internal, and not sprayed onto the outside of the plant	1 mark
	where they could kill other butterflies and moths.	1 mark

	Being internal, the ICPs will only kill insects that eat the plant but there is concern that pollen may also carry the ICP. If the pollen is blown onto other plants, it may kill butterflies and moths eating these plants.	1 mark 1 mark 1 mark
7 f)	Any one of the following (or any other suitable suggestion) Is pollen from other or all GM plants toxic? Is GM pollen equally toxic to all butterflies and moths? What distance can GM pollen travel? Can insects develop a resistance to the *Bt* GM crop?	1 mark

